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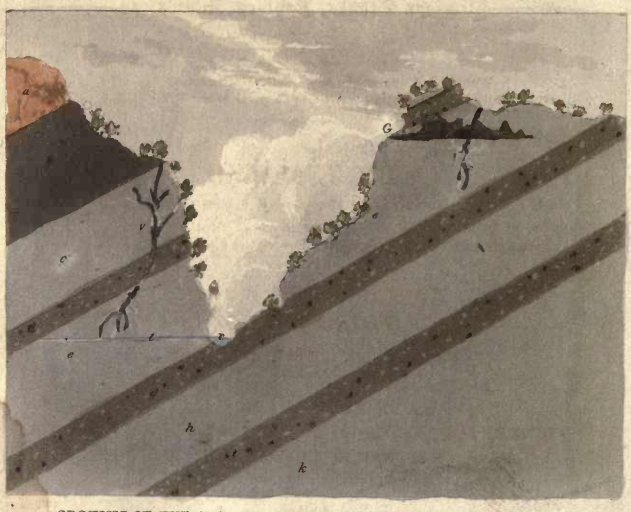
A BRAZILIAN MINER WASHING THE ALLUVIAL SOIL
(RAKED FROM THE RIVULET) FOR GOLD & DIAMONDS.



SECTION OF THE STRATA AT MATLOCK HIGH TOR DERBYSHIRE.

FAMILIAR
LESSONS
ON
MINERALOGY AND GEOLOGY;

EXPLAINING

THE EASIEST METHODS OF DISCRIMINATING

METALS, EARTHS, AND ROCKS,

WITH COLOURED PLATES.

To which is added,

A PRACTICAL DESCRIPTION OF THE USE OF THE

LAPIDARIES' APPARATUS,

SHEWING AND DESCRIBING THE METHOD OF CUTTING, SLITTING, AND POLISHING,

Precious Stones, Pebbles, Agates, &c.

Whose hand unseen the Works of Nature dooms,
By Laws unknown—WHO GIVES AND WHO RESUMES.

BY J. MAWE,

Honorary Member of the Mineralogical Society of Jena, &c. &c.

Author of Travels through the Gold and Diamond District of Brazil; Treatise on Diamonds and Precious Stones, New Descriptive Catalogue of Minerals, &c.

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PREFACE.

The Author, fully aware of the difficulties the beginner has to encounter in reading elementary works on Mineralogy, has carefully avoided tedious details and technical phraseology, studiously aiming at simplicity of description, and concise explanation, that the learner may be led straight forward to the objects, and enabled to discriminate one Mineral from another, the substances that compose the mountains, and the ground on which he treads.

Mineralogy may be contemplated in two points of view. It may be considered as closely connected with the more common affairs of life, and consequently inviting us to pursue it from its *utility*, or by affording to us continual examples of regularity, the undeviating order of nature, it may, like Astronomy, accustom the student to sublime speculations, and become the means of enlarging and dignifying the faculties of his understanding.

The possessor of landed estates, the artisan and manufacturer, can all render Mineralogy subservient to their respective advantage, and the object of these

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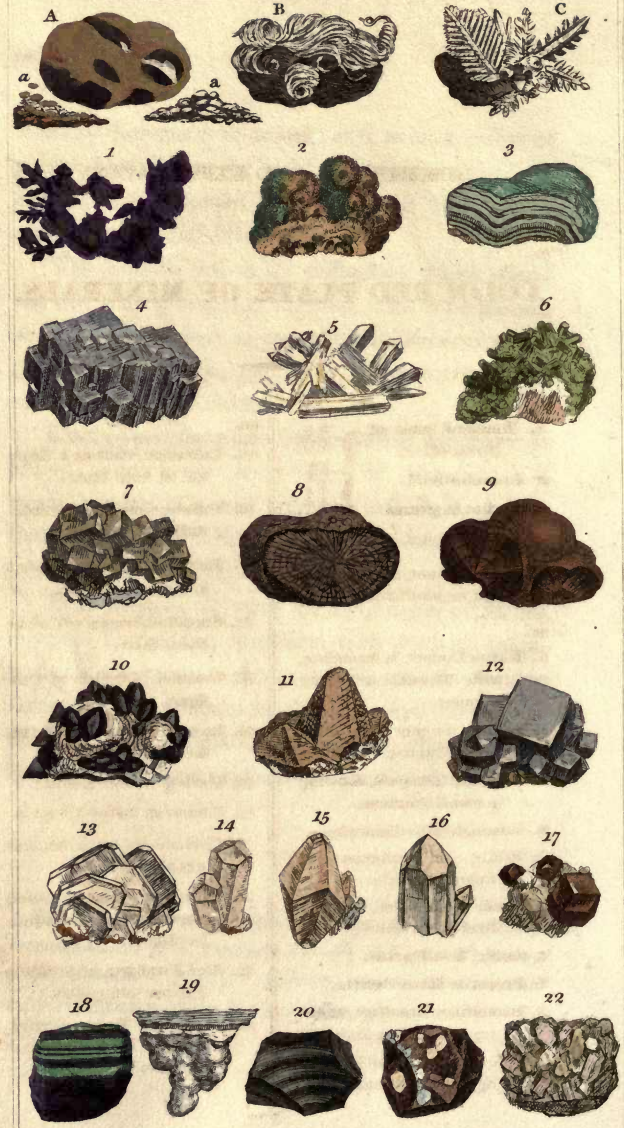
Familiar Lessons is to unlock, as it were, a casket of useful knowledge, by easy explanations, and to present to the learner a compendious view of the vast importance of Mineralogy.

The Author, feeling the difficulties which attend any one who attempts to simplify what is perplexed, or disentangle what is complicated, undertakes the present little Work, the result of his practical observations, with diffidence.

Costly specimens are by no means necessary to obtain a competent knowledge of Minerals. A careful perusal of a well arranged collection, not too limited, will benefit the student more than hundreds expended in mere rarities.

It is needless to state the advantages of Mineralogical knowledge, connected with chemical information; the pursuit of one opens so many pleasing facts, as to be certain to lead to the other; the learner thus becomes delighted, and almost imperceptibly introduced to a practical acquaintance with both.

☞ *The Author gratefully acknowledges the favour of many recommendations from Professor Brande, R.I., the Professors of the Universities, Professor Jameson, also to the President, and many Members of the Geological Society.*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DESCRIPTION AND EXPLANATION

OF THE

COLOURED PLATE OF MINERALS.

A. Rounded mass of Native Gold.
a. Granular Gold.
a. Platina in grains.
} Found by washing the soil.

B. Native Silver, in curls.

C. Native Silver, arborescent, and crystallized.

NO.

1. Native Copper, in branches, with Crystals of Ruby Copper.
2. Yellow Copper Ore, Blistered Copper.
3. Malachite, striped, showing a zoned fracture.
4. Common Cubic Lead Ore.
5. White, or Carbonate of Lead, accicular.
6. Green Lead Ore, crystallized in six-sided prisms.
7. Cubic, Iron Pyrites.
8. Brown, or Liver Pyrites.
9. Hæmatites, Iron Ore, shewing a diverging fracture.
10. Blende, an Ore of Zinc, in aggregate Crystals.

NO.

11. Calamine, coating a Crystal of Calc Spar.
12. Violet coloured Fluor crystallized in cubes.
13. Barytes, tabular, beveled edges and corners.
14. Six-sided Crystal of Calcarious Spar.
15. Common Crystal of Calc Spar.
16. Rock Crystal or Quartz, hexagonal.
17. Garnets, dodecahedron.
18. Ribbon or striped Jasper.
19. Chalcedony, stalactitic and mammilated.
20. Obsidian, Volcanic Glass, shewing a conchoidal fracture.
21. Red Porphyry, with White Felspar embedded.
22. Common Red Granite, Quartz, Mica, and flesh-coloured Felspar.

PRELIMINARY OBSERVATIONS.

The learner will more readily obtain a knowledge of Minerals by applying to a little chemical assistance, which will prove of great importance, and greatly facilitate his inquiries. The acids dissolve the metals, which, when in solution, may be precipitated under various forms and colours. These pretty experiments may be made in small glass tubes or watch glasses, following the directions herein contained.

The aid of the blow-pipe is indispensable; it is scarcely possible to find words sufficiently strong to convey the importance and the use of this little instrument, for, by blowing through it across the flame of a candle, such an intense degree of heat is instantly produced, as to melt small particles of Gold, Silver, Copper, &c., when placed on a bit of charcoal, and held in contact with the point of the flame. These experiments are particularly interesting, and so immediately under the eye of the practitioner, that he cannot refrain from observing the changes which take place on the application of heat, the vapours, the colour of the slag (more particularly when borax is used), elucidates many important facts; the whole of the materials necessary for such examinations, scarcely occupies the space of a tea-caddy.

The learner should provide himself with a few small bottles for acids and tests, a proper knife, and a steel mortar; with the assistance of these much may be done by himself, but in the first instance one lesson from a practitioner will be worth a volume of letter-press.

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FAMILIAR LESSONS

ON

Mineralogy.

LESSON I.

TO explain what is meant by FOSSILS or MINERALS, and to instruct the learner how to distinguish one substance from another, is the subject of the following pages.

Minerals are dispersed in the earth, and commonly deposited in what are termed veins, *fissures* *, which, when worked, are called mines, whether at the greatest depth we have penetrated, or in the alluvial soil on the surface. Be it Spar, Coal, or any Metallic substance, it is called a Mineral. The gems are usually called Stones, and crystallizations, Fossils; yet all are ranked under the term Minerals. A distinct piece is commonly denominated a Specimen, and a number of various substances, a Collection.

It is true, that this science is not marked by those distinguishing laws, that are the leading features of the Sister sciences, yet a general knowledge may be attained

* See Geological Part.

with little difficulty, although the way to set about it may appear rather clouded and a little obscure; when, however, this mist is once cleared, a brilliant display of Useful knowledge is opened to our senses, and by beginning under the following directions, considerable progress may be made in a few days, and afterwards the learner will be enabled to instruct himself.

To imagine that any one unacquainted with minerals can define and say what they are at first sight, would be as unreasonable as to expect that an unlettered man should discriminate classical authors without seeing the title-page of their works!

Without further preface, I will endeavour to point out the most easy method for the learner, who may have a few Minerals, to prove to himself and determine what they are, *viz.*

Suppose any one to possess Lead Ore, Rock Crystal or *Quartz*, shining yellow Pyrites, or Calcareous Spar, and a few Pebbles that have been found on the sea shore;—these substances are selected as being the most common and generally met with:—further, I will for example suppose him to ask,

How can I satisfy myself that this Specimen is Lead Ore, or this Rock Crystal, or this Pyrites, and this Calcareous Spar?

In reply to the first question—Observe the colour, and remark its great weight, both of which approach lead; break a small portion, and notice the fragments and their metallic lustre—it will be soft and brittle if cut with the knife, or place a bit not larger than a pepper-corn on a piece of charcoal, then with the blow-pipe blow through

the flame of the candle, directing the jet of flame proceeding from it upon the Lead Ore; it will almost instantly discharge sulphureous vapours, and in less than half a minute melt to Lead. The experiment being attended with this result, furnishes a decided answer.

The ores of this metal are both various and numerous; the most common is blue Lead Ore, resembling lead, which occurs in great quantity, and from it lead is chiefly produced.

Other ores of lead are white and green, also yellow, red, &c. which may generally be discovered by their weight—they all soon yield to the blow-pipe, and melt in small globules to lead. If a particle (of any of them) be reduced to powder, and put into a glass tube, with a few drops of nitrous acid diluted, and held over the flame of a candle, it will effervesce strongly; into which immerge a piece of zink, and the lead will precipitate upon it in a metallic state!

The white ores of Lead become orange and red at different degrees of heat, and some varieties decrepitate or start from the charcoal on the sudden application of the flame, to prevent which, reduce it to powder, with a little borax, or apply the heat very gradually.

HOW TO DETERMINE CRYSTAL* *Quartz* FROM OTHER SUBSTANCES.

Rock Crystal, when pure, is perfectly transparent, but it is subject to specks and flaws; it occurs, gene-

* The general term *Crystal* signifies Rock Crystal; but we say,

rally, presenting six sides terminated by a point; when not crystallized, it has the appearance of a piece of broken glass, but not so heavy; it may always be known by its hardness; it cannot be scratched with the knife; it gives fire with steel; its fracture is almost invariably shining and uneven, often curvilinear: the fragments are very sharp and irregular; heat has no effect on it, but if reduced to fine powder, and mixed with potass or soda, it melts and forms glass: after once comparing Crystal and Calcareous Spar together, and trying their hardness against each other, or with a knife, the learner will instantly discover the softest to be Carbonate of Lime—Spar. These substances are the most common in mining districts, and frequently confounded with each other.

White Topaz resembles Crystal, but is much harder and heavier; it has, when broken, a flat and smooth surface; is generally found rounded by attrition.

Quartz is a variety of Crystal, less transparent, often opaque, and sometimes of different colours, as blue, pink, yellow, &c.

These easy experiments, performed in a few minutes so satisfactorily, cannot fail to lead the learner forward; they are the foundation of the science, and may be considered the first letters of the alphabet.

The exterior form of crystals, fragments, fracture, nice discrimination, tact, &c. belonging to minerals, cannot be known as it were by *magic*, or attained all at once: books afford but little information to the beginner, and indeed for him, what are considered the best books, may be deemed the worst, as they often disgust by tediously

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a Crystal of Topaz, a Crystal of Lead, a Crystal of Quartz, &c. which denotes the substance to have a geometric form.

dwelling upon the most trivial variety. Such works may be useful to the connoisseur, and to the minute investigator, but are unintelligible and unfit for those who are generally unacquainted with minerals.

LIMESTONE *.—CALCAREOUS SPAR.

HOW THEY MAY BE KNOWN.

What is called Spar is one of the most common productions in the mining counties of England, particularly Derbyshire, and is generally understood to be a brittle shining substance, that will burn to Lime; but Spar is not a very definite term, as Crystal *quartz* is called Spar in Cornwall. We have also other varieties, as Adamantine Spar, Felspar, &c.

To know if the substance is Calcareous (carbonate of lime), proceed as follows:—Apply the point of a knife, and if it is brittle and easily scratched, leaving a white powder, it may be presumed to be Calcareous Spar, or by placing a few fragments on a hot fire shovel, they will become opaque, and burn to Lime, which may be known by its styptic taste, or by throwing a particle into a glass of water, it will fall to powder with a hissing noise. Calcareous Spar exhibits a smooth glass-like shining surface; when broken, the fragments will be of a rhombic form; it effervesces with acids, even with strong vinegar, if applied to it when reduced to powder; when transparent, particularly the Icelandic variety, it

* Limestone may be known by the action of acid upon it, causing it to throw up bubbles of air (effervescing), or by burning to lime.

has the property, in a high degree, of reflecting objects double, arising from its great power of refraction. This effect may be best seen by placing a pin underneath it, when two will appear more or less distant from each other, as the piece of Spar is thick or thin. This singular and pleasing effect has not yet been fully accounted for.

Let it now be supposed the learner has received some shining yellow *Pyrites* *, which being very heavy, he believes it to be Gold, or to contain Gold.

HOW TO PROCEED TO KNOW YELLOW PYRITES FROM GOLD.

The application of the knife or hammer will soon determine this. Endeavour to cut the specimen; if it is Gold, it will be soft, and easily yield to the knife like lead, or if it be struck gently with the hammer, it will be indented, Gold being malleable: if a small particle be melted with the blow-pipe, its colour will remain yellow the same; but if it be brittle and hard, it is a proof that it is not Gold: if a few fragments are placed upon a hot fire shovel, or under the flame of the blow-pipe, the sulphur will burn away, leaving a dark-coloured scoria, that will be attracted by the magnet, which proves it to be a combination of Sulphur and Iron; this is answering

* How many, having met with this common substance, both abroad and at home, have treasured it with the greatest secrecy, believing they had discovered a Gold mine. Brazil, Rio de la Plata, Africa, &c. can testify the mistakes many travellers have made by not being able to discriminate one from the other.

this interesting question with great facility: or if he put a few of the particles into a glass tube, previously containing a little nitric acid, and hold it over the flame of a lamp or candle until it boils, if it be Gold, no alteration will take place; but if not, considerable action, agitation, effervescence, and change of colour will be the result, which shews that the substance has been acted upon (dissolved more or less) by the acid; the contents may be thrown into a glass of water, into which, if a few drops of the test for iron (prussiate of potass) be thrown into it, the liquid will become a beautiful blue. The Iron of the Pyrites being dissolved by the acid, and held in solution in the water, is as it were regenerated, and precipitated in the form of Prussian Blue, after which the water again becomes clear. This elegant and easy proof cannot fail to give pleasure to the learner, and shews that useful knowledge of Minerals is to be obtained without difficulty, and will not fail to prepare and encourage his mind for other experiments, with the pleasing advantage of introducing chemical information.

GOLD.

HOW IT MAY BE KNOWN, AND WHERE IT IS USUALLY FOUND.

Gold is generally obtained from the alluvial soil, in small lumps or particles, called grains or Gold dust, seldom so large as a pea. What are called the Gold mines of Brazil and Africa are on the surface: the simple act of washing the soil of peculiar places separates the Gold from the gravel, and by this means great quantities are found. In Brazil alone, above twenty tons

weight are annually procured, which forms a large share of the circulating medium of Europe. The principal mining district is called *Minas Gerais;* the reader will learn with surprise that it does not contain one deep mine or one subterraneous excavation! What is there termed a mine, is a peculiar place, the bed of a river or bottom of a ravine, of greater or less extent, where the surface is raked from or dug down to the solid rock. This surface consists of rounded substances, earthy matter, gravel; sometimes *Precious Stones*, as *Topaz*, *Aqua-marinas*, &c. are found in it, besides Gold and Diamonds, *of which it is the great receptacle* *.

This argues, that these particles of Gold have been disseminated in the mountains, and which, from the decomposition of their exterior, have been washed down by heavy rain to their present situation. It is common to see Pyrites so *dispersed* in Limestone, and I have some specimens where the gold is so distributed in Jasper and Granite, but they are very rare.

Particles of Gold are sometimes so extremely delicate, as to float on water; another variety is so small that it cannot be separated from the accompanying heavy ferruginous matter, without mercury, (which, on being strongly triturated, takes up the gold) and amalgamates with it.

In Africa Gold Dust is an article of commerce, and considerable quantities are exposed for sale. It is often adulterated with such Pyrites which is the nearest to it in colour, and not unfrequently with Brass filings, which the merchants appear not to know how to detect, and from the want of *this sort* of knowledge, many have

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* See Frontispiece.

suffered great loss; some of the better informed negroes make a trade of "trying Gold," and are called "Tryers." Merchants and captains pay them particular attention and respect when they are employed on this business, as from their *slight knowledge* they save their employers from imposition; on these days the poor negro is admitted to the captain's table.

HOW TO DETECT GOLD DUST THAT HAS BEEN ADULTERATED.

Place a little of the Gold dust in a glass tube or earthenware saucer, and pour upon it Nitric acid; if the glass or saucer be placed over a flame, or upon a few embers, until red fumes (nitric vapours) arise: if it be pure gold it will not become discoloured, but if it be adulterated with pyrites or brass filings, &c. that resemble gold, the acid will become turbid, green, and black, discharging bubbles of air: after the ebullition has ceased, washing it with water and repeating the acid, will finally leave the Gold dust pure.

PLATINA

Is found also in grains, the same way as Gold; it is heavier than granular Gold, and of a white colour, more like Silver, hence called Platina, being the diminutive of *Plata*, meaning silver in the Spanish language. It is only met with in some peculiar gold washings in Mexico, and in one or two in Brazil.

PYRITES.

There are many varieties; some contain a large portion of arsenic, and are then called Arsenical Pyrites, the colour of which is from pale yellow to almost tin white, and may be known also when exposed to heat by the fumes and peculiar smell, like garlic. Pyrites is always hard and brittle, often crystallized in the forms of cubes and octohedrons.

HOW TO DETERMINE CRYSTAL, WHITE TOPAZ, &c. FROM ROUGH DIAMONDS.

Rounded stones, forming a part of alluvial soil, gravel, or gathered from the sea coast, &c. may, with little examination and attention, be generally known and determined.

ON DIAMONDS.

How many gather Pebbles, small rounded Crystal, believing them to be Diamonds; indeed, so little are Diamonds known in their native state, that it is difficult to convince *some* pebble collectors that they are not so, even after they have been cut and polished!

As it is well known that Diamonds cut glass, many imagine that a Crystal *(Pebble)*, gathered from these sources, hard enough to *scratch* it, and shine when polished, must either be a Diamond, or something nearly related to it! This is not to be wondered at, when it is

considered how few have seen rough Diamonds, or have ever given it a thought, that there is a difference between *scratching* and *cutting glass.*

The Diamond acts so extraordinarily upon glass, that however thick the plate, it separates frequently in the very act of drawing the Diamond over, as if cut asunder, whereas other substances merely scratch it, and do not produce any other effect. Rock Crystal, compared with Diamond, is not so heavy by about one-third. Large Diamonds are extremely rare, therefore those generally offered for sale, in the rough state, from Brazil or India, are very small, seldom so large as a nut, but more commonly about the size of a small pea; they have almost always *a sort* of shining metallic hue and a crystalline form, exhibiting planes and angles different from those of any stone. The beginner, without confining himself to these marks of discrimination, may procure a fine file, and rub the substance with a little pressure; if it be a pebble, the file may with difficulty leave an impression;—if it be small, place it betwixt two penny pieces, and strongly press them with the thumb and finger, it will break and be reduced to powder if it is not a Diamond; or he may try it on a lapidaries' wheel, the Crystal, &c. will be instantly worn, but it will not produce any effect on the Diamond. A glazier's diamond will determine the hardness of any stone, which it will easily cut, but it will not produce any effect on its own species.

White Topaz, Minas Nova, White Sapphires, and Chrysoberyls, resemble Diamond more than Crystal; but the diamond cuts them with great ease, nor will they resist pressure betwixt two penny pieces.

Diamonds may easily be known from stones which

are cut in brilliant, and polished, so as to resemble them. The light will pass through the Crystal, paste, &c.; whereas in the Diamond, the rays are, by its great refractive powers, reflected to the surface, which gives it the highly marked rank it holds in society, *viz.* Diamonds are always known by the beholder, who, however distant, distinguishes the dazzling flash, the reflected ray of light, which is not the case with stones or paste; they are only seen by those who are nearest to them.

Rough Crystal, Pebbles, often appear rounded and opaque, also as if polished, presenting, *when perfect*, eighteen planes: many have brought them from Surinam, Maravina, &c. *for Diamonds;* the best method of obtaining a real knowledge of their difference, is by comparing them together.

After due attention to these remarks, transparent substances will not be mistaken for Diamonds.

ROUNDED STONES, PEBBLES.

SUBSTANCES USUALLY MET WITH ON THE SEA COAST.

HOW TO DETERMINE WHAT THEY ARE.

The substances from these sources are commonly hard and siliceous, as Quartz and Crystal, already noticed; they are rounded, and often of a brown colour.

Flint is too generally known to need description.

Jaspers, Chalcedony, Agates, the varieties of which are numerous in these situations. They all give fire when struck against steel, do not yield to the knife, and

when broken, have generally a shining, curved, or uneven fracture; the fragments are splintery and sharp edged. Their general characters may be considered as follows:

JASPERS,

Are very numerous, and consist of great variety; some are much interlinked with Agate, although their formation is different. Jaspers are of many colours, as brown, red, yellow, green, &c.; they often form a part of Agate in red stripes and angular lines, blotches, spots, dendritic, and moss-like appearances; also curious resemblances of *Lusus Natura*, some of which are highly valued.

Jasper is of a fine texture; exterior appearance, smooth, and often strongly coloured, red, yellow, &c.; it is very tough and difficult to break, and contains a large portion of Iron, particularly the red.

CHALCEDONY,

Often occurs rounded amongst the Pebbles of the sea shore: it is of very close texture; fracture, not shining; colour generally pale milk blue; is often marked by straight white lines, parallel to each other, and frequently resembles zoned carnelian.

AGATE,

Is a substance so generally known, as to need but little description: many are particularly beautiful when cut and polished. Agate commonly consists of Chal-

cedony, Quartz, and Jasper, the angular and concentric lines, the Crystals of Quartz frequently lining cavities, serve to shew that their exterior was formed first, and that they have been filled by a siliceous deposit in solution at distant periods, and owe their colour to Iron. The exterior of Agate is rough and spheroidal, often indented, and generally of a dirty green colour.

A mere sight of these substances will impress the mind of the learner so that he will not need more information than that of comparison.

Many collectors have a small lapidaries' apparatus for cutting and polishing Pebbles, which will perform all the operations; it is also extremely useful for polishing shells, &c. and so portable as to be set on a parlour table, and may be used with great facility.

Rounded pieces of *Granite*, *Green Stone*, and *Porphyry*, occur less frequently in this situation, though they are not uncommon, therefore it may not be improper to notice them in this place.

GRANITE,

Is composed of three distinct substances, viz. Mica, Quartz, and Feldspar, which the learner will easily discriminate, after once having had the substances pointed out and explained. (See Granite.)

GREEN STONE,

Is composed of Hornblend and Feldspar: it is generally hard, and of a dull green colour, often spotted. Horn-

blend is both light and dark green, often gives the same tinge to Feldspar, but is not so hard.

PORPHYRY,

Is a substance that equals Jasper in hardness, and is generally of a brown or red brown colour, speckled with whitish spots; these spots are very seldom round, almost always angular. Porphyry is often met with in a decomposing state; it then is much softer, and finally becomes Clay.

Limestone, *Slate*, *Sandstone*, and semi-indurated *Argillaceous* substances, rarely occur in *Gravel*, or amongst the Pebbles of a surf-beaten sea-coast; because they are not sufficiently hard to resist the action of attrition, and are soon broken down, forming sand and dust.

A little thought on these substances, after examining and looking at them with attention, will convince the learner that he is making some progress, and he will feel pleased at being enabled to proceed with greater facility.

The preceding may be considered the most common substances in the Mineral Kingdom, with the exception of Gold, which is merely brought forward to distinguish it from Pyrites. Travellers both abroad and at home frequently mistake the one for the other.

Gold Dust, Diamonds, &c. must be seen and noticed, to be known: afterwards they will not be generally mistaken.

LESSON II.

COPPER.

HOW TO DISCRIMINATE ORES OF COPPER.

Copper Ores are found in abundance and in great variety; but as it is not my intention in this little work to endeavour to explain all their appearances, I shall merely describe the substance generally, and explain the easiest method of detecting them, previously observing, that Copper is not uncommon in its native state, when it appears as if compressed in leaves, foliated, massive, branch-like, &c.; pieces of this description are often found in veins, particularly in Cornwall: this sort of Copper so much resembles the general Copper of commerce, in colour and texture, that it needs no other description.

The learner will easily detect *Native Copper* by its colour, and by it being little harder than lead; also bright and flexible. The ores, whether grey or yellow, will be more or less hard to the knife as they are poor or rich, the best being the softest: or let him place a small particle of it upon a piece of charcoal, with a little borax, directing the flame from the blow-pipe upon it, the ore will soon melt, and if it be rich in metal, it will be reduced to a bead of pure Copper, colouring the borax green, or red brown; it is sometimes necessary to repeat the ope-

ration. Ores of Copper, if combined with arsenical acid, may be known by their being easily fused, and giving copious vapours, which smell of garlic.

Phosphates of Copper may be known by their melting as soon as the flame is applied, producing a brown slag. Muriate of Copper tinges the flame a beautiful blue, and afterwards an emerald green colour.

A more easy method of detecting Ores of Copper is as follows:

Reduce a small particle to powder; put it into a glass tube or watch glass, with a few drops of diluted nitric acid; if no action takes place, apply a little heat, by holding it over the flame of a lamp; the Copper will soon be acted upon and dissolved by the acid, then add a few drops of water, and stir it with the point of a knife, or any piece of clean iron, when the Copper which was held in solution will precipitate and cover it, or the contents of the watch-glass may be thrown into a glass of water; to which add a few drops of liquid ammonia, and it will become a beautiful blue.

This pretty experiment, so convincing in effect, will add considerably to the learner's confidence *.

Even water passing through a vein of this metal, often contains a large portion of it in solution. These waters are collected in reservoirs with great care, into which Iron of any description is thrown, and in a few

* A similar effect will be produced by using an Ore of Nickel; should any doubt exist, let sulphuric or nitric acid be added to the solution, slightly in excess, when the immersion of a bar of Zinc will precipitate any Copper which may be present, but no effect will be produced on Nickel; should a dirty mud coloured precipitate take place, it may be found to arise from a mixture of Arsenic and Iron, with which common specimens of Nickel abound.

days it becomes coated with a strong covering of Copper, which is scraped off, and the Iron again plunged into the water; this is repeated so long as any Copper remains in it, and frequently by this method several tons are obtained. The metal thus produced is very pure, and used for the finest purposes.

Ores of Copper have commonly a yellow appearance, the poorer Ores much resembling Pyrites, and contain a large portion of Sulphur and Iron, but are softer to the touch of the knife. Copper Ores, that are richer, are of a Gold yellow; some are irridescent, exhibiting a pretty and variable display of colour, and are called Peacock Copper. These varieties have a deeper and more flame-like tinge than common Pyrites.

Copper Ores are also frequently green, and in delicate fibres; sometimes compact, beautifully zoned, of lighter and darker shades, exhibiting great variety: these are called Malachite, which is not unfrequently mixed with blue, of various shades.

Copper Ores are often shining metallic grey, not unlike Iron, ruby-red, brick-red, earthy-black, even soot-like; also blue of various shades, from dark to light, and in fact wherever green and blue occur, Copper may be generally suspected, which the learner can (from the preceding rules) so easily detect.

The before-named substances are amongst those which most generally occur in this country; it is not my intention, nor would it suit the learner in this early stage, to enter into more varieties or their peculiarities, or more minute detail; that may take place hereafter.

SILVER.

As *Silver* has been met with in various parts of Cornwall and Devonshire, the learner will naturally desire

HOW TO PROCEED TO DISCRIMINATE ORES OF SILVER.

Native or *Virgin Silver*, as it is sometimes called, occurs in delicate curled fibres, of a silk white colour, and filling little cavities in *quartz*, nests; these fibres are tough and flexible, often surrounded by a black, earthy, soot-like substance. Silver is frequently branch-like in strong ramifications, or leaf-like; also passing through Spar and other substances, in long serrated wire-like branches, detached or connected, and frequently interwoven, crossing each other net-like. These Silvers have often a fine rich metallic lustre, of a tin-white colour, and sometimes tarnished when they become black.

Silver in this state, *Native Silver*, cannot be mistaken after having been once examined, but it may be proved by the touch of the knife, as it yields to it, being little harder than lead; it is malleable, and indented by the smallest blow of the hammer, and melts into a beautiful white globule.

It greatly resembles Tin in colour, but may be easily known from that metal, being much heavier, and by the cracking noise which Tin makes when bending, or by the latter burning away under a continued heat, whereas Silver remains unaltered.

By due attention to these remarks, Native Silver may be always discovered.

Ores of Silver are frequently combined with other metals; the following easy experiment will detect it.

If it be a rich ore it will be soft to the knife or hammer, and melt under the blow-pipe with little difficulty, and by repeated fusing with borax, a bead of Silver may be produced; the combinations will be driven off by heat, or be mixed with the borax, forming slag.

Or a few small particles of the Ore may be put into a glass tube, into which drop a little nitric acid, then hold it over the flame until it is dissolved, after which dilute it with water, and stir it about with a bright Copper wire; if any Silver is present, it will precipitate upon the Copper, in a muddy dull coating, covering it with Silver, (not exactly as Iron is before described to be covered with Copper;) or add to the solution one drop of muriatic acid or a little common salt, and the Silver will precipitate in a thick and dull white cloud *.

If the ore contains a large portion of Copper, which is frequently the case, it will shew itself in melting, by colouring the borax green, also by superficially coating the Silver, and finally burn away with a green flame, if the heat be continued.

If the ore contains Lead, it will be more easily driven

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* Lead also is precipitated by the muriatic salts, but the two metals may be easily distinguished: the precipitate occasioned by the presence of Silver quickly turns black by exposure to light, and is perfectly insoluble in water. That resulting from Lead is not affected by light, is soluble in about 25 times its bulk of boiling water, and also in nitric acid.

off by heat, colouring the charcoal a whitish yellow: other combinations, as Sulphur, Arsenic, Antimony, and Bismuth, become easily evaporated.

Ores of Silver are very commonly combined with the above-named metals, which may be known by the fumes. Antimony burns with a thick white smoke. Sulphur and Arsenic may be detected by the smell.

These experiments will open the mind to further investigation. They may be performed with ease and elegance, by merely possessing the few tests before mentioned.

Thus far the learner will be led to the most useful, and through the goodness of Providence, the most plentiful substance in nature.

IRON.

What could be substituted for this metal?

Ores of Iron. Iron presents itself in great abundance, and exhibits variety of appearances, and may generally be detected by the magnet, or by placing a small particle under the flame of the blow-pipe to drive off the sulphur, &c.; it will not melt, but after it has been kept red-hot a few moments, the magnet will exert its unerring power, and attract it; (many varieties not being magnetic until exposed to heat;) or, reduce the particles to powder, which put into a glass-tube, to which add a drop or two of *sulphuric* acid, and expose it to the flame of a lamp; throw the contents into a glass of water, into which pour a little tincture of galls, and you will have

Ink; or a beautiful blue, if prussiate of potash be used instead of the tincture of galls.

The most general Ore of England, from which Iron is made, is *Clay Iron Stone*, which may be considered a deposit. It is almost always found near Coal, which is so necessary for melting it, in order to produce Iron. So common as this useful metal is, yet how few know any thing of the process it undergoes before it becomes malleable, and applicable to our wants. It is one of the most difficult Ores to reduce, and more art and labour is requisite to conduct a small Iron furnace, than to melt all the Gold produced in Brazil; and here I particularly recommend to the learner to consider how a piece of Iron Ore is worked, so as to convert it into the useful form of a knife, as a subject well worth his notice.

Pyrites. The most abundant of all minerals is always of a yellow colour, frequently brilliant and beautiful, crystallized in groups or detached cubes, &c.; also massive; is a combination of Sulphur and Iron, which has before been named. This Ore of Iron is often disseminated in fine particles, in Spar Limestone and Coal, scarcely any mine is worked where it is not produced. In Cornwall it is called Mundick, and in Derbyshire, Brazil.

The variety of crystallized forms which it assumes, form a beautiful series.

It may always be known by its giving sulphureous vapours when exposed to heat, or by its being brittle to the touch of the knife.

Clay, Sandstone, and Jaspers, frequently contain a considerable proportion of this metal, which gives to

them their red colour. In some stages it is more subject to decomposition than in others, and the more Iron they contain, the more tinged the substance becomes, the colour being generally brown or yellow. Many indurated clay-like stones appear ochreous, and on breaking them, two or three stages of decomposition are instructively and beautifully marked, elucidating their change; whereas the centre remains perfect, unaltered, hard, not having yet been affected by either water or air, the action of which has given the surface so different an appearance.

Other Ores of Iron, as those called *Hematites*, are red, often *Black*, *Red*, and *Brown*, with a fibrous texture; kidney shaped, and have a metallic appearance; they are heavy, and frequently appear as if polished; they are also sometimes encrusted with red dusty matter, which soils the fingers.

There are yet others, granular and compact, as *Loadstone* and shining *Specular Iron Ores;* some have the appearance of aggregated particles of Iron or Steel. The beautiful Ore from Elba presents itself in large crystallized groups, of the most beautiful colours, and of the greatest splendor; but this series, so interesting to the uses of man, is leading me beyond the bounds I had prescribed myself.

Sandy Iron Ores are in great abundance, and occur in Alluvial soil, more particularly in rivers and streams bounded by Granite mountains, and always accompany Gold Dust in great quantity.

MANGANESE

Is a substance of a dark colour and earthy appearance, frequently attendant on Iron Ores and Ochreous Substances; commonly occurs near the surface, and is used in glass manufactories, and in bleaching.

HOW AND IN WHAT MANNER TO DETECT MANGANESE.

Let it be first understood that the Ores of Manganese cannot be reduced to metal by the blow-pipe, and in order to detect them, observe as follows, viz.:

Manganese in its general appearance is earthy, brown, and black, soils the fingers when touched, and frequently contains delicate fibres of a bright iron-like lustre. Another variety is striated and accicular, of a metallic appearance and heavy, is soft to the knife, and after regarding it, may easily be distinguished from any other mineral. It also occurs with earthy substances, tinging them a beautiful rose or pink colour.

Put a small portion, reduced to powder, in a glass, to which add a little muriatic acid, and hold it over the flame of a lamp. If Manganese be present, it will occasion a disengagement of gas (Chlorine), which may be known by its suffocating odour, and by its discharging the colour from printed linen previously moistened, if exposed to the fumes.

With the blow-pipe Manganese presents some curious and pleasing phenomena. A very small particle, after being exposed to a red heat, placed on charcoal, with ten times its bulk of borax, and fused by the inte-

rior flame, forms a globule of a violet colour; suffer it to cool, and gently remelt it, and the colour will be found to have vanished. It may be reproduced by again melting it with the exterior yellow flame, or by adding a bit of nitre, which will be best seen by drawing it whilst melted into fibres with a pair of forceps.

Manganese is supposed to give the colour to Amethysts, and other beautiful gems. Calcareous Spar and Quartz derive their pink tinge from it. The dendritical appearances on various substances, and the beautiful moss-like representations in Mocha stones, owe their origin to it. Manganese is common in Devonshire, and worth about 7*l.* per ton. It is of the first importance in making glass, and has been called the mineral Camelion!

I cannot sufficiently recommend an acquaintance with the preceding substances, and the different methods of discrimination; for if the learner has once familiarized himself with the characters of them, and with the means of detecting what they are, he will then have gained the first steps to the knowledge of mineralogy as a science, from which too many have started back, and could not prevail upon themselves to proceed.

Ascertaining metallic substances by these easy experiments, will give the learner some idea of the invaluable use of chemistry, with which almost every thing useful to man is connected, and cannot be too earnestly cultivated.

LESSON III.

ON THE GENERAL APPEARANCE OF THE ORES OF TIN.

HOW TO DETECT THEM.

Tin may be detected by digesting a portion of the Ore in muriatic acid, and adding a few drops of muriate of gold, which will produce a purple precipitate: it is essential that both the solutions should be fresh prepared. The muriate of gold may be readily formed, by putting a little gold-leaf into a glass tube, with a small quantity of muriatic acid, and adding nitric acid, by a few drops at a time, until the solution is effected; it will be facilitated, by exposing the tube to a moderate heat, over a spirit lamp.

The general use of *Tin* naturally presents itself to the notice of the teacher; it is not so much distributed as many other Minerals, but its ores exist in abundance where it has hitherto been found. It is one of the heaviest minerals and one of the lightest metals. It consists of few varieties; which may generally be known by their great weight; it is sometimes of a resinous colour, but commonly approaching black, and its crystals occur in groups, presenting planes, often intersecting each other, which mostly have a lustre as if polished. It is hard, and with difficulty scratched by the knife. It

forms veins, some of which are so delicate, as not to be thicker than the blade of a knife. It also is met with in small heavy pieces, having a diverging striæ, and a ligneous appearance; hence called Wood Tin.

Tin does not associate with lead, and rarely with other metals, except Blende, and sometimes Copper, nor is it attended by Calcareous Spar; but Fluor occurs frequently with it.

The Ores of this metal are not easily reduced; but after being exposed to a red heat, they should be pulverized, and mixed with soda and charcoal, then exposed to the blow-pipe, on a clay support; minute globules of Tin will appear. Care must be taken not to continue the heat, or it will burn, and become a white powder. The same Ore, melted with glass, will produce an opaque enamel.

Ores of Tin cannot be described, so as to give a perfect idea of them; they resemble Ores of Iron in some cases, also Ores of Blende; but are harder, much heavier, and will not be mistaken, after observing the preceding description: on comparison, the learner will be enabled to distinguish Tin from those ores which resemble it.

Ores of Tin have hitherto only been discovered in the Granitic Rocks and Clay Slate; they have not been found in any part of this kingdom but Cornwall and Devonshire!

ZINC.

It is extremely useful and agreeable to be enabled to discriminate one substance from another.

ORES OF ZINC.

HOW THEY MAY BE KNOWN, AND THEIR USE.

Ores of Zinc form two distinct substances, as *Blende* or *Black Jack*, and *Calamine*, both of which present several varieties, though they form the same metal.

Blende is commonly black, brown, or yellow, of different shades; is massive, and often appearing in clusters (confusedly crystallized) upon the surface of specimens, and may be known by the touch of the knife, being soft, and by scratching it, a lighter coloured powder is produced; some of the yellow variety, when rubbed, even with a pen, yields phosphorescent sparks. These Ores are neither so heavy or so hard as Tin, and by comparison they may be readily distinguished. Under the strong flame of the blow-pipe Blende evaporates and goes off in white flakes.

Common Calamine, both in its crystallized and amorphous state, bears considerable resemblance to some of the earthy minerals, and frequently cellular, not unlike bone; its superior weight will, however, lead to a suspicion of its metallic nature. From Argillaceous Stones it will be distinguished, by the want of their peculiar

odour when breathed on, and by not becoming tenacious when moistened; it also effervesces strongly in acids. From the Carbonates of Barytes and Lime it may be known, by placing on the back of the hand a particle which has been recently exposed to the blow-pipe; on moistening it, the heat which is evolved under these circumstances by the above-named earths, will not be experienced. Before the blow-pipe it is infusible, but loses about one-third of its weight; and if the heat is continued, it escapes in white particles. In nitric acid, moderately diluted and warmed, it dissolves with considerable rapidity and effervescence; pour a small quantity of the solution into a glass tube, and on adding ammonia, a white precipitate will ensue, which will re-dissolve on adding an excess of ammonia. A slip of paper immersed in the solution, and then held within a few inches of glowing coals, will kindle spontaneously soon after it is dry. On slowly evaporating the solution, the crystals which form will detonate when projected on ignited charcoal: these characters sufficiently distinguish it from other minerals.

Calamine occurs in masses, brown, yellow, and green; also diverging, crystallized in transparent crystals, forming elegant groups; has more commonly an earthy appearance of a brownish colour; it is generally porous, but sometimes compact, and this species, when struck, yields a metallic sound. Some varieties become electric on being warmed, and are hard enough to give sparks with steel. It is in great abundance in Derbyshire, and other limestone countries; it is used to convert copper into brass. Ores of Zinc are a late discovery, that metal being imported from China formerly.

A new metal, called Cadmium, has lately been discovered in the Derbyshire Calamine.

The presence of Zinc in any ore may also be known by mixing a small portion of it with a few grains of Copper filings, and a little charcoal; on cautiously applying the flame of the blow-pipe, so as not to volatilize the Zinc, the Copper will be found converted into Brass. Should an Ore of Blende be used in this experiment it will be necessary to subject it previously to a moderate heat, to drive off the sulphur.

A very pretty experiment is performed with a small particle of Zinc, which though so generally known, I will detail, for the purpose of shewing the great affinity it has for lead.

Example. Lead is acted upon by vinegar, and forms acetate or sugar of lead, which, when dissolved in water, is a transparent liquid solution, leaving a white precipitate. If a piece of Zinc be suspended by a thread, and immerged in the fluid, it will be covered almost instantly by the finest flakes of lead, regenerated in its metallic state, which may be seen approaching it in all directions.

This beautiful, amusing, and instructive experiment, cannot sufficiently be admired; it is a lesson upon attraction and affinity, which cannot fail to please those who have not heretofore seen it performed.

I have felt it my duty to be thus explicit in stating how the ores of the three last metals (so useful in our occupations) might be known chemically, in order that the learner may not be checked in his progress, though

he will more readily distinguish what they are by examining and comparing them with others.

MERCURY.

When Mercury, commonly called Quicksilver, occurs in the state of Ore,

HOW IT MAY BE KNOWN IN ITS (ROUGH AND) NATURAL APPEARANCE.

Quicksilver once seen, cannot be mistaken; it exists in semi-indurated Clay, in Sandstone, and other earthy productions; it often occurs in small and large fluid globules, commonly attended with a red substance; large quantities are obtained in the fluid state. The Ores, from which the greatest quantity of Mercury is obtained, are called Cinnabar, which, when rich, are extremely heavy, compared with Iron. They are of a red and brown red colour; some varieties are dull, others bright and shining; they may always be known, if rich, by their great weight, or from the knife leaving a full red streak upon them, or by exposing a particle to the flame of the blow-pipe, white fumes will arise, and a piece of Gold, as a guinea, or a piece of bright Copper, as a half-penny, held over the vapour, will be coated with Mercury, which condenses upon it; and the more it is rubbed the more it will have the appearance of Silver, which cannot easily be removed, but by burning it off. Quicksilver, as a metal, is always fluid in our atmosphere; it may be rendered solid by producing artificial cold. The ores of Mercury are not generally distributed,

but where they are found, they occur in considerable abundance, as at Idria, Almaden, and Deux Ponts.

COBALT.

HOW ORES OF COBALT MAY BE KNOWN, AND THEIR USE.

Perhaps the learner is not acquainted, that the metal called *Cobalt* forms the beautiful blue colour on China, also earthenware, and may be desirous to know how to distinguish Ores of that metal, as it has not been found in a native state.

The Ores of Cobalt are not confined to one peculiar sort: they, like many of the preceding, consist of several varieties, some of which are rich, and yield a great quantity of colouring matter, which is highly valuable; others are too poor to pay the expence of being worked. The Ores are generally combined or accompanied with a large portion of arsenic. They have a whitish grey colour, and metal-like lustre, sometimes tarnished, and approaching to black; they are very heavy and hard to the knife.

On examination, some of these ores have more or less intermixture of peach-red efflorescence; others are dark, earthy, sometimes of various colours, from intermixture of other metals, as black, blue, and green; the latter varieties often occur in Sandstone. The best Cobalt is produced from the Swedish ores.

A very small particle, placed under the flame of the blow-pipe, generally emits fumes of arsenic, after which, if it be reduced to powder, and a little borax be melted with it, a deep-coloured blue glass will be pro-

duced; Cobalt, melted with Silex, is called smalts. The Ores of this metal occur in Mica Slate, and frequently in detached splendent crystals, of a white metallic lustre; generally cubic or in octohedrons, variously modified. Many amusing experiments may be made with Cobalt, which Parkes's excellent Chemical Catechism explains.

Ores of this metal have lately been found in Clay Slate in Cornwall, and in the alluvial soil in Cheshire, accompanied by Copper, Manganese, and Lead.

ANTIMONY.

HOW THE ORES OF ANTIMONY MAY BE KNOWN.

Antimony is much used in making Printer's types; also in Medicine and other purposes. It may always be distinguished from Galena by being much lighter.

It does not form so many varieties as several of the preceding. It is generally of a lead colour, and frequently occurs in long thin Crystals, like needles, diverging from a centre, and of beautiful irridescent colours. It is also shining bright; this variety resembles Lead Ore, but it more commonly occurs of a dull metallic grey, compact, or composed of acicular fibres. The massive variety is sometimes covered with a yellowish Ochre, arising from the decomposition of the metal, which is not the case with Ores of Lead. Antimony, after being attentively examined, cannot be mistaken for any other substance. It is soft to the knife and very brittle. The flame of the blow-pipe will immediately detect it, as it melts the instant it is exposed to

heat, and then appears as a dark-coloured slag or scoria, swelling and burning entirely away in white fumes.

BISMUTH. NICKEL.

Perhaps the learner has never heard of the metals called *Bismuth* and *Nickel;* they are not common, and their use is rather confined; with Bismuth and Tin a soft solder is formed and used by glaziers.

Bismuth is a metal that is not malleable, though it is found in a native state, but more generally combined with Sulphur, and sometimes accompanied by Lead.

Bismuth has a peculiarly agreeable metallic appearance of various colours, generally resembling the hue of a Pigeon's Neck, changeable as the light strikes it; which peculiarity may serve to distinguish it from granular Lead Ore. It is soft, and melts the moment it receives the flame, into a white globule, which, if the heat be continued, volatilizes, leaving a white deposit upon the Charcoal.

Bismuth frequently accompanies Ores of Silver, Cobalt, and Nickel, and as its varieties are very few, the learner will be enabled to determine them, after having discerned their peculiarities, by comparing them with other metallic substances.

Nickel is a metal less known than the preceding; but, if the learner has carefully examined the characters of the metals which have been already described, he will be in no danger of confounding it with any of them. It

contains above half its weight of Arsenic, and is often called Kupfernickel.

Nickel is massive and compact, not so dark as Copper, though approaching to it. It is hard, difficultly scratched by the knife, and is very heavy; any further description would avail little or nothing, as the characters before described are sufficient to distinguish it from any other substance. It produces a fine apple-green colour in nitric acid. It melts rather difficultly, emitting arsenical fumes that smell like garlic. From this description the learner will not confound it with the metals that it is often associated with. Copper, alloyed with Nickel, forms a compound metal resembling Gold, which is called Petit Or.

URANITE.

Uranium, *Uranite*, is more easily known than the preceding.

Uranite cannot be mistaken for any other substance, if its characters are carefully examined. It is of a beautiful grass-green colour, rarely yellow-green, and generally appears in tender delicate leaf-like quadrangular crystals, which, uniting together in clusters, often present a surface half an inch or an inch across. It sometimes occurs in an ochreous state, both green and yellow; another variety, called *Pitch Ore*, is black, and often accompanied by the ochre; it is extremely heavy, and of rare occurrence. Uranite has been plentifully found in Cornwall lately; it forms very beautiful specimens, which are of considerable value.

WOLFRAM.

HOW IT MAY BE KNOWN.

Wolfram is a common Mineral in Cornwall, though hitherto of very limited use. It is of a dark colour, approaching to black; brittle, fracture foliated, and hard. It yields a *red brown* streak to the knife, and is extremely heavy. It differs from Ores of Tin and Iron in these particulars, and is one of those Minerals of which words cannot convey a perfect idea to the learner. It is rarely met with, except in the countries which produce Tin; it is a Tungstate of Iron, consisting of Tungstic acid 78, Iron, and Manganese.

The following Tungstate of Lime is allied to the preceding.

Tungstein (Tungstate of Lime) is a heavy, opaque, white-coloured Mineral, sometimes yellowish brown; it often occurs in fragments, is very compact, and may be known by its great weight; it differs from massive Carbonate of Lead, by being harder, and not effervescing with acid.

These Minerals are not of common occurrence, and their use is extremely confined; for more particulars the reader had better refer to the New Descriptive Catalogue, or some Elementary Work.

The same remark applies to the following; viz.

TITANIUM.

Titanium is a Mineral more generally diffused than the preceding, and occurs under a variety of forms, some of which may be known by their beautiful capillary appearance in rock crystal. It is generally of a brown or red brown colour, often lighter, and as delicate as hair—hence it is sometimes called Venus's Hair; it also presents itself in a regular form, as thick as a quill. Another variety is found imbedded and wedge-like. Titanium exhibits beautiful appearances in Quartz, of which it is impossible for description alone to give a just idea.

Menachanite belongs to Titanium; it is found in grains of a black colour, interspersed with sand, and resembles gunpowder. There are other varieties that occur in larger and smaller grains, which are generally affected by the magnet, less sensibly than the preceding.

Gold Ore is frequently asked for, and many yellow substances are believed to be ores of Gold; but the following is a mineral which contains that precious Metal, without the smallest appearance of it; it is called

TELLURIUM.

Tellurium is a whitish-coloured shining Mineral, disseminated superficially, in small and delicate leaves and fibres, of a polished steel colour, often appearing map-like, and from this character it is named Graphic Ore.

It is sometimes yellowish, and there is a variety that approaches to black; the latter is rich in Gold, and occurs in larger foliæ; they both yield to the knife, and a bead of Gold may be obtained from the richest variety, by melting it with borax. The Graphic variety cannot be mistaken, and the others may easily be discriminated. Tellurium is of rare occurrence, and the learner will seldom meet with it. It is found in Transylvania.

MOLYBDENA.

Molybdena is a Mineral not very abundant, though it occurs in many situations; it is generally in small patches, foliated, of a lead colour; it greatly resembles Tellurium, but its leaves are more flexible, and it crystallizes in six-sided tabular plates; it does not melt under the flame of the blow-pipe: it is commonly imbedded in Quartz, and has hitherto only been found in Granitic rocks; it much resembles plumbago, common black lead, but marks porcelain or earthenware with a greenish streak; it is considered to be one of the oldest metals, and always occurs in the primitive rocks; its use is very confined.

TANTALITE—COLUMBITE.

The two following varieties belong to Tantalite, and are of late discovery.

Tantalum. Columbium generally occurs imbedded in Granite; it is of a black colour, sometimes streaked, and greatly resembles Wolfram and Ores of Iron, but it is not magnetic: consists of Columbite, Iron, and Manganese.

Yttrotantalite, Yttrocolumbite, is found imbedded in angular fragments, but more generally forming concretions of a black colour; it is nearly allied to the preceding; it consists of the new earth Yttra, Oxide of Tantalite, and Oxide of Iron.

These substances are extremely rare, and their uses hitherto so very limited, that I did not, at the commencement of this work, mean to have given them, nor the following, a place in it.

CERIUM.

A new metal, which is also of late discovery.

Cerite is of a red brown colour, dull appearance, and moderately heavy; it melts partially under the blowpipe, and forms a dark scoria, which is attracted by the magnet; consists of 50 Oxide of Cerium, Iron, and Silex.

ORTHITE, *Fluate of Cerium,* and other varieties of *Cerium,* are but little known.

CHROMIUM.

Chromic acid occurs combined with Lead and Iron; hence Chromate of Lead and Chromate of Iron.

CADMIUM.

A new metal, resembling Tin, lately discovered in an ore of Zinc, from the Hartz.

Doctor Clarke, of Cambridge, has also found the same metal in a peculiar variety of Calamine, from Derbyshire.

WODANUM

Is also a new discovery, with which we are but little acquainted.

SILENUM

Is a late discovery, and said to be obtained from the Sulphur of the Pyrites, from Fahlun in Sweden.

These metals have not hitherto been applied to any useful purpose, and, in fact, we know very little about them.

It is the Author's desire that the learner should speedily be enabled to discriminate minerals of common occurrence, which a little practice will enable him to do, without the assistance of chemical aid, or entering the labyrinth of elementary works; but should any doubt arise in his mind, a knowledge of the means of ascertaining them will greatly add to his confidence, and he will soon perceive the unnecessary complexity of terms and minutiæ which has prevented thousands from attempting to cultivate an acquaintance with the most useful part of this science.

OBSERVATIONS RESPECTING THE VEINS AND METALS.

After having enumerated the metals in the preceding Lessons, and endeavoured to explain, in a concise manner, how they may be known, a question very naturally arises, viz.:

HOW ARE THEY FORMED?

By the term vein is meant a fissure, separating the rock or strata, and becoming filled with Metallic Ores, Crystallizations, and substances, differing from the rock in which it is situated. These fissures in rocks must have existed prior to their becoming filled with minerals, but in what manner they have been deposited in these receptacles, is yet considered doubtful: there are numerous objections to the theories hitherto advanced. However, it may not be improper to state the following observations relative to some Minerals which appear to be formed by aqueous deposit, and others that exhibit characters of being produced by sublimation, having first premised a description of the veins in which they are found, and of which there are many varieties. Some appear to have been fissures of great extent, taking a direction nearly east and west; these are considered the richest mines, and are worked with the greatest

profit; they are also supposed to be the oldest. Others again, called cross veins, run nearly in a north and south direction, and are of less importance than the former, yet some good mines are also worked in them. Whether these rents have been formed by desiccation, or by natural convulsions (perhaps by both), philosophers are yet in the dark.

Veins differ in their magnitude and position; some are from sixty to a hundred feet wide in some parts, and not more than ten or twenty in others; these are commonly filled with what is called vein stuff, mixed with the metal; others are only a few inches wide: in the primitive rocks, the veins containing metal, are commonly associated with Quartz, Pyrites, and sometimes Fluor, rarely Calcareous Spar; in the Secondary and Floetz formation, the metallic veins are filled with Calcareous Spar, Barytes, Fluor, Blende, and Pyrites. The Lead Ores in the primitive rocks contain a much larger proportion of Silver than Lead Ores in the metalliferous Limestone of the Floetz formation.

Pyrites (*Sulphur* and *Iron*) is the most abundant substance in the mineral kingdom. I do not remember to have seen a mine without its presence, from the oldest to the newest formation, and it is often disseminated in rocks. The veins before stated, considered as Fissures or Rents, are not perpendicular, but inclining more or less, and are often open from the surface of the earth down to twenty or thirty fathoms; however, these are not the only repositories for metals; there are other deposits reverse to the preceding, which are called flat or *pipe veins;* where the solid rock forms the roof and bottom of the mine, these are deemed irregular in their direction and magnitude, having an appearance like a series of

small caverns, connected with each other. The top, bottom, and boundaries are lined, and sometimes filled with Lead Ore, and its attendants, particularly Stalactite, Fluor, and Barytes; some of these have produced a vast quantity of both Lead and Copper.

Derbyshire presents great variety; the high mountains and deep ravines exhibit the strata, the stratification, and the veins in a most instructive manner, particularly in the neighbourhood of *Matlock.* It is worthy of notice that Lead Ore is met with in NESTS in solid Limestone, and it is found penetrating the entrochite and fossil shells!

It should be considered that Lead is supposed to lie much below the Coal; the Coal formation being composed of various sorts of grit, which lies above the Limestone, and is allowed to be a later formation. Iron seems to be so universally distributed, that there is scarcely an earthy substance into which it does not enter, and is the principal means and cause of their becoming decomposed.

There can be no doubt that the ores of some metals are continually forming, as Calamine and Manganese; the former is often found cementing fragments, and coating recently fractured Calcareous Spar, and the latter may be observed deposited in newly made water courses.

Carbonate of Lead, accompanied by Galena, has been found forming Stalactite, which seems to prove that they were held in solution, and precipitated where the impulse of attraction became strongest. It is well known, that several metallic ores, with their associates, line the roofs and sides of caverns, which are evidently produced by infiltration.

In the deposit of Metals, and in their apparent formation, the electric fluid may have had some action with which we are unacquainted.

Metallic substances having existed in vaporous exhalation is equally certain *, from the quantities which have been met with, formed by sublimation. The great operations of nature in her vast laboratory are much beyond the limited comprehension of man; by stating these circumstances which have occurred within our own observation, it may be preparing the way for the learner to make more attentive researches.

The Rocks in which these metallic repositories are situated, whether of Granite, the primitive order, or the more recent formation, mountain Limestone, do not, on analysis, contain a particle of the metal which they enclose! Metals are frequently imbedded in Rock Crystal, Calcareous Spar, Barytes, &c.; it is not easy to imagine that Gold, Silver, Antimony, and Titanium, in tender and delicate capillary fibres, could force their way through substances so much harder, nor is there any reason to suppose that these metallic filaments were first formed, and afterwards enveloped by a deposit of the substances before named. Minerals obey the universal and most powerful laws of nature—attraction and affinity; therefore, it may be fair to suppose the possibility of their having existed together, and afterwards, simultaneously influenced, separated, and became crystallized, each after its own peculiar laws.

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* As Ores of Arsenic, Antimony, Zinc, &c.

REMARKS.

Having given this brief description of Metals, it may not be improper to say something relative to the situation they respectively occupy in the Earth, before they are brought from it, and afterwards subjected to those necessary operations, in order to become useful.

Gold often occurs in a foliated form, in Transylvania and Siberia, in veins filled with other substances, where it is generally found laminated, imbedded, crystallized, and disseminated; rounded lumps of it have been found in Ireland, Sumatra, South America, Cornwall, Scotland, &c. which, as well as minute particles called Gold dust, are met with in alluvial soil. It must be remarked that the soil, nearest to the rock, (immediately upon it,) is the richest in precious metal.

Native Gold varies greatly in its purity; sometimes it is found containing one fourth part of Silver or Copper, or both, and never quite pure. It is always, when granular, attended by ferruginous matter, particularly Iron Sand.

Platina (though more rare) is found in the same manner. Throughout the Gold district of Brazil I did not see one vein of Gold; and although that precious

Metal may sometimes appear in short ramifications (in Quartz), yet I did not see or hear of any thing like what is understood by a vein, of any regular continuance, filled with Gold *, throughout Brazil. The most productive mine was in the alluvial soil, under a small bed of Scaly Iron Ore, where a thin stratum of Gold, in delicate foliæ, was intermixed with it.

Silver, Native Silver, and Silver Ores, occur with Quartz, Calcareous Spar, &c. filling fissures (veins) in the stratum, also accompanying other Metals, and not unfrequently combined with them. Silver is often rich in Gold, and Gold frequently contains Silver. In the North of England, and more particularly in Devonshire and Cornwall, the Lead Ore contains a considerable proportion of Silver, which is extracted from it. Some varieties of Ore have produced above a hundred ounces of Silver in the ton of Lead. The Lead Ore is accompanied with Fluor Spar, filling and forming what are termed veins, in which are made excavations to great depths, and their produce brought to the surface by mechanical power.

The principal mines of Silver are in Mexico, Potosi, and Peru, where above forty millions of dollars have been annually coined.

Native Silver and Ores of Silver are of late discovery in Cornwall, as are Ores of Cobalt; both these valuable metals have been thrown away, until latterly; since Mineralogy has been more attended to, minerals have been better understood.

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* I have a specimen of Gold, in my possession, ten ounces in weight; also the finest Crystals of that substance hitherto seen.

Tin, Copper, Lead, &c. are extracted from veins of larger or smaller magnitude. These Ores are frequently very difficult to obtain; in many cases they require a great deal of skill, and extremely hazardous labour; after they are brought from their subterraneous abode, they are dressed, that is, broken in small pieces, and separated, by a tedious process of washing, from the earthy substances which adhered to them, and ultimately submitted to the furnace, before they can be presented in a useful state. The Ores of Tin are found only in Cornwall and Devonshire.

It will appear singular, that although Cornwall has been known as a mining country above two thousand years, yet no notice was taken of the Ores of Copper that were met with in working for Tin, until the beginning of the last century.

How confined must then have been the knowledge of minerals amongst the owners of mines! Thousands of tons of this valuable material remained unnoticed, or served only to mend the roads. Since that epoch, perhaps not less than £100,000,000 sterling have been produced from the Copper Ores of Cornwall!! and at a rude estimate Cornwall produces at present above a million annually in Copper.

So little were the Ores of Lead known (except common blue lead ore) in our time, that both white and green ores of that substance have been for years lying neglected on heaps both in Derbyshire and Wales, which have since been turned to a very profitable account; nay, of late years, a road repaired with White Lead Ore and Calamine, has been taken up and smelted!!!

Copper Ores and Native Copper, occur most abund-

ant in Granite and Clay Slate, particularly in Cornwall, where they are associated with Quartz; but the great mine of rich Copper, at Ecton, in Derbyshire, is situated in Limestone, and is attended with Lead Ore, Blende, Calcareous Spar, and Fluor.

Veins of *Tin* occur only in the older or primitive rocks, as Clay Slate and Granite (consequently it is considered one of the oldest metals); they are generally accompanied with Fluor, Pyrites, and Blende. Some veins are extremely delicate and capillary, although 50 or 100 fathoms below the surface.

The Ores of Tin present but little variety, nor are they so commonly met with as any of the preceding metals, yet wherever an ore of this metal has been discovered it has occurred in considerable abundance; in some places it is mixed with, and forms a part of the alluvial deposit, from which great quantities have been washed; in the Island of Banca a thin stratum of Tin Ore lies below the alluvial soil in the valleys, which is worked at an easy rate, and is productive of great profit. This Ore appears to have existed in a massive bed, but it is found in fragments.

The most instructive collections for beginners are composed of those minerals which are in general use, and commonly met with. It is necessary to observe that the metals present great variety, which must be seen and examined before their characters can be so well known as to enable the learner to discriminate them from each other.

The student, after having perused these pages, will be induced to reflect on the importance of Mineralogy. Many kingdoms owe their wealth and greatness to their mineral productions, and individuals innumerable have been enriched by the produce of mines. The washing the alluvial soil, whether for Gold or Tin, is immaterial, if it is advantageous. The coal we possess is the foundation of our national strength, as well as our riches, and worth to England more than all the Gold mines of Peru, which it has rendered subservient to our manufactories.

It cannot but be interesting and agreeable to the mind also to know the Rocks and Metals, as Granite from Limestone, or Lead Ore from Copper, although not interested in the pursuit of Minerals.

Even this information would, in many instances, have proved of importance, as Limestone has often been transported to various places abroad, where it has since been discovered on the spot. Slag has been bought for Copper, and Tin for Silver, by early visitors to South America.

It is unaccountable that the composition of mountains, the great features of the globe which we inhabit, always beneath our feet, and not unfrequently above our heads, have hereto been generally unnoticed and disregarded even by those who are deeply interested in the productions of the soil.

GEOLOGY.

DESCRIPTION OF THE VARIOUS EARTHS THAT FORM THE SURFACE OF THE GLOBE.

LESSON IV.

EARTHS are commonly understood to be composed of substances neither metallic nor inflammable, though many of this class contain various proportions of the former, particularly Iron *, and some are combined with the latter.

The beginner must inform himself of the names of those substances generally called *Earths;* they are but few, and those most commonly met with are only five, viz. the *Siliceous*, *Calcareous*, *Argillaceous*, *Magnesian*, and *Barytic;* to which is added the *Strontian;* none of which have hitherto been met with in a state of purity, being always associated with one or more substances, either chemically combined or mechanically compounded.

These I purpose to treat of in the following pages, and endeavour to explain their general characters, and

* Recent experiments have tended to shew that the Earths are compounds, and that some are considered to have metallic bases.

the peculiarities which may distinguish them from each other in the common state of their ordinary appearances.

There are four other Earths which are very little known, viz. *Zirconia*, *Glucine*, *Yttra*, and *Thorina;* but these seldom occur, and the beginner, who is desirous to know more of them, may consult an elementary work*.

The surface of the globe, mountains, valleys, the bottom of the deep, and the whole united mass of the Terrestrial Orb, are comprised in the universal term EARTH, and are believed to be chiefly composed of the four † first named, blended or combined in all the degrees and forms in which the Infinite Power, who created it, has thought fit to present it to our view.

As Siliceous substances are supposed to be in greater proportion than any of the others, I will endeavour to shew how they may generally be known.

Siliceous Earth or *Silex* ‡ occurs in great abundance in GRANITE, which is composed of QUARTZ, FELSPAR, and MICA; sometimes distinctly crystallized, but generally confusedly aggregated; these are understood to have been the first chemical deposits, when Earth obeyed the

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* *Barytes*, *Strontian*, *Zirconia*, *Glucine*, *Yttra*, and *Thorina*. These Earths are very limited: the first is not uncommon in this country, the next may be said to be seldom met with, and the four others are of rare occurrence. Zirconia exists in the Zircon. Glucine exists in the Emerald, Beryl, and Euclace; Yttra in the Gadolonite; and Thorina in Cerium.

† *Siliceous*, *Calcareous*, *Argillaceous*, and *Magnesian*.

‡ Silex, Lat. Flint. The word Silex has given way to that of Quartz, which will in future be used in this treatise.

ALMIGHTY FIAT, separated from chaos, and formed (the greater part of) the globe, the immense mountains of *Granite* and *Granitic Rocks*, which sometimes alternate with others, supposed to be of the same Primitive—the earliest formation.

GRANITE.

Granite forms the highest mountains, some of which are the most rugged and peaked that have hitherto been explored, also the general course of Alpine countries; and the deepest ravines *, having frequently immense tracts of various formations, betwixt its lofty points, forming mountains of different elevations, rocks, hills, and valleys of great extent, or ravines more or less confined. (See plate A.)

Of this (comparatively) almost universal formation, GRANITE, the substance called Crystal or Quartz, forms a principal part, and may be known from its associates, *Felspar* and *Mica*, by observing the following characters. Some varieties of *Granite* are very small-grained, consequently the component parts are more difficult to be distinguished than in others, therefore, I recommend to the beginner, first to examine specimens

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* Imagine a valley of any extent, betwixt two lofty points of Granite, to have been subject to repeated influx and inundations, which have brought together as into a reservoir both animal and vegetable remains; also, the decomposed particles of its confines; such a tract would present a very different appearance from that of *Granite*, and would constitute what is termed the filling up or flat formation †, consisting of stratified and homogeneous deposits.

† Ger. Floetz formation. See plate C.

of the large-grained, in which the three substances may be more distinctly seen, and to notice with attention each constituent part separately.

HOW QUARTZ MAY BE KNOWN IN GRANITE.

Quartz (Silex *), the immediate subject of our inquiry, has generally a shining lustre, is of a light colour, and not unlike glass; the fracture is uneven, irregular, not of any determinate form; it is sometimes imbedded in Felspar, and when broken across, resembles Hebrew characters. It is commonly opaque, approaching white, and not unfrequently smoky, grey, or brown, of different shades; these are its usual appearances, though it occurs yellow, pale or deep pink, and approaching to red; also violet blue. It is hard to the knife, but a good file will make an impression; it easily scratches glass.

Quartz appears massive, also in regular and irregular forms, compressed or aggregated. If diaphanous and very fine, it is then called Crystal, or *Rock Crystal*, some varieties of which are of various colours, as has

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* Silex consists of Silicum and Oxygen, the latter in the greatest proportion. Berzelius states it at 54 per cent. Oxygen may be understood by the learner as the cause of Iron rusting. Thus a nail, exposed to the air, becomes covered with a brown powder, which is termed rust; in endeavouring to explain this, I hope to be pardoned; this powder (the rust of Iron), having absorbed Oxygen from the air, is an Oxide of Iron.

Iron entering into the composition of earthy substances, attracts Oxygen from the atmosphere, and gives to them brown and red brown colours.

Oxygen is the mineralizer of many metallic ores, particularly Tin, which occasions its great weight.

been before stated. Silex is also in great abundance in other Rock formations besides Granite; Quartz forms extensive veins, patches of great magnitude, skirting or covering Rocks, and there are few metals that it is not associated with.

Silex is so universally diffused, that it would be difficult to say where it is not. Flint, Chalcedony, Agates, Jaspers, Aggregates, Petrified Wood, Hornstone, Felspar, Clays, Mica, &c. &c. partake largely of this substance; and the very numerous and extensive class called Sandstones, coarse and fine, and of almost every denomination, are composed of it, whether reduced to Pebbles, Gravel, to large or small-grained Sand, and to the finest particles called dust, in which state it enters succulent vegetables, the stems of corn, &c. to which it adheres in the early stage of their growth, adding strength, and being conducive to their perfection.

HOW FELSPAR MAY BE KNOWN IN GRANITE

FELSPAR *. This constituent of Granite † is generally in greater proportion than others; it is not so hard as Quartz.

When a piece of Granite is broken, the crystals of

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* *Felspar* contains a portion of Potass, which hastens it to decomposition, forming Clay; this alkali meeting with Iron in the state of Oxide or Sulphuret, produces various changes in the appearances of Granite.

This substance, properly speaking, belongs to the Argillaceous Class; but as it is a constituent of Granite, I have thought it best to describe it here.

† Granite sometimes contains a large portion of Hornblende

Felspar will generally appear as if split or divided, with a smooth flat fracture, and a regular form, or a tendency towards it, which is not the case with Quartz.

Felspar is commonly a light grey colour, and has a shining, pearly, and silk-like lustre; it is often pale or deep red, and then forms red Granite. It is sometimes transparent, also blue and green; Labrador, or irridescent Felspar, is very beautiful; it is massive, and exhibits the finest variety of colours, in the same specimen.

Felspar occurs in distinct crystals; but it is generally aggregated, confusedly crystallized with Quartz and Mica; also sometimes disintegrated. It is often in decomposition, when it becomes dull, earthy, and passes into Clay. If these characters are well noticed, Felspar will easily be distinguished.

MICA,

EASILY DISTINGUISHED IN GRANITE.

Mica, the remaining constituent of Granite, is generally of a yellowish colour, and has a strong metallic lustre; it is composed of delicate foliæ, splitting or separating as thin as fine paper, and is extremely elastic. In mass it has frequently a smoky brownish tinge, but in fine laminæ is commonly transparent, and used to cover objects for the microscope; it is employed in Russia for windows, hence called Muscovy glass. It is often

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(see Magnesian Order), which, in some cases, resembles Mica. Tourmaline and Schorl are often imbedded in it, also Precious Stones.

seen in soil, and at the bottoms of rivulets, in South America, and many travellers have brought it home and believed it to be gold! Mica is soft, easily scratched by the knife, and produces a white flaky powder. It belongs to the magnesian order; but as it forms a constituent of Granite, I have thought it best to explain its characters to the beginner, after those of Quartz and Felspar, as they associate together and form Granite. Mica contains a portion of Iron, Potass, and Manganese, all of which tend to hasten it to decomposition.

THE

ARGILLACEOUS ORDER

CONTAINS A LARGE PORTION OF SILEX,

And is considered next in abundance; it commonly appears in the form of Clay, and is more or less indurated.

Primitive Schistos, or *Clay Slate*, belongs to this order, which often presents itself, alternating with Granite. In it are veins filled with Quartz, Fluor, &c. also various metallic substances. Clay Slate is of a dull dark colour, bluish black; lamellous; splits freely, absorbs moisture, has an earthy smell when breathed upon; is soft when scraped, and cannot be mistaken after being once examined.

Primitive Porphyry is very hard and compact; colour red brown, with angular spots of a faint yellow. It

occurs dark green, with patches light coloured. The variety called Egyptian Porphyry is the most valued.

Green Stones, from containing a great portion of Felspar, belong to this order; and though they are so intermixed with Hornblende, which is frequently in minute particles, yet the Felspar may be known by its lustre and flaky appearance. It is very difficult to determine the relative position of many varieties from specimens.

Basalt, *Trap*, *Grau-wacce*, *Toad-stone*, and *Shale*, contain large portions of Argil and Silex.

These substances, when decomposed (to which many varieties are so subject), form Clay. The Felspars produce the finest, which is used to make China and the best earthenware. Clay-slate, Shale, and the coarse varieties, when decomposed, are used by potters, and for making bricks. The beginner may discriminate common Argillaceous substances, merely by wetting, and their becoming tenacious, or by breathing on them, when they give out an earthy odour.

LIMESTONE,

COMBINED WITH CARBONIC ACID.

Primitive Limestone occurs in beds, or filling fissures in the Granite formation. It is granular and crystallized, also compact, as that from the Isle of Tiree. It

does not contain any animal remains or vegetable impressions; it is not common amongst the Primitive Rocks, neither is it abundant, in the Transition formation; in which it sometimes contains traces of petrified organic remains.

In the Secondary, or what is termed the Flat Formation, Limestone is very generally distributed, forming mountains comparatively of less magnitude, valleys, and plains; it exhibits regular marks of stratification, shewing evident signs of an aqueous deposit at different and distant periods, appearing in great part to be formed of Marine petrifactions.

These mountains, though of small extent, present perpendicular and very rugged features, as if separated from each other by some violent concussion, dislocating their strata, and in many situations, throwing the surface in great confusion. In this formation are situated fissures and veins of great depth and magnitude, which are filled with metallic substances, generally Lead Ore, and accompanied with Ores of Zinc, Barytes, and Calcareous Spar. There are instances of veins being worked in this Limestone from two to four or five miles in length, producing an immense quantity of lead.

Those Limestones which take a good polish are called Marble, they consist of innumerable varieties, according to the figures of the marine exuviæ of which they are composed.

The Black Marble is most esteemed, and the best is in Derbyshire, near Ashford, where mills are erected for working it; also at Derby, both of which are in the possession of Mr. Brown of that place.

Chalk belongs to this order; it pervades a considerable extent of country, and is too well known to need any description. It contains a large portion of shells, &c. in a petrified state.

Gypsum, *Alabaster*, is Lime combined with sulphuric acid *. It is very abundant in Derbyshire and Nottinghamshire, and forms a considerable extent of country, filling cavities in the Red Marl, and rising into low hills. It is soft, and may be scratched by the nail, which sufficiently distinguishes it from Marble. It is in great use, and when burnt, it forms plaster of Paris, and is used in forming busts, mouldings, and flooring.

Selenite, a crystallized and transparent variety, is sometimes found detached; it contains a larger portion of water than Gypsum.

After the preceding Earths, so generally distributed, the *Magnesian* claims our attention; it does not occur, by any means, in so great a proportion as the others; on the contrary, it may be deemed scarce, though it enters some Limestones.

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* Lime, combined with Fluoric Acid, forms the beautiful fossil, called Fluor; that variety from which such elegant and beautiful vases are made in Derby, is peculiar to one mine. Fluor has generally a cubic form. Fluoric Acid attacks and corrodes glass, which no other acid acts upon.

MAGNESIAN ORDER.

MAGNESIA IS ALWAYS COMBINED WITH OTHER EARTHS.

The substance called Serpentine belongs to it, which occurs at the Lizard, in Cornwall, in a tract several miles in extent; another variety is found in Scotland; it is also met with in other countries. Many of the Traps and Amygdaloids contain portions of Magnesian earth, which may be known by their being slippery or greasy to the touch; Mica, Talc, Asbestos, and the soap-like substance, Steatite, contain large portions of it combined with Iron.

Hornblende, a substance very generally diffused, forms a part in Granitic Rocks, Gneiss and Sienite, also in Serpentine; it may be known from Mica on being gently struck with the small end of a hammer, so as to abrade it; or scrape it with a knife, and a dull green powder will be produced; it contains a large portion of Iron, and is very abundantly disseminated in Basalt, Trap, Amygdaloids, and Green Stones; when in decomposition it is ferruginous, and frequently gives the red colour to Clay, particularly if associated with Felspar.

SULPHATE OF BARYTES,

BARYTES COMBINED WITH SULPHURIC ACID.

Barytic Minerals form so small a portion of the Earth's surface, that they rather belong to the class of fossils,

and though by no means scarce in this country, yet they are so limited, as not to admit of the most distant comparison with any of the preceding; they are commonly found in veins, and may be known by their great weight. They yield to the knife, and are frequently massive, and of an earthy texture, resembling Chalk, also crystallized and transparent. Barytes is an alkaline earth, becomes caustic on being exposed to a strong heat, and ultimately melts.

CARBONATE OF BARYTES,

CARBONIC ACID AND BARYTES.

A variety, called *Carbonate of Barytes*, is more rare; it has generally a striated and diverging fracture; is very compact, and, as Common Barytes, may be known by its great weight; it effervesces with diluted acids.

SULPHATE OF STRONTIAN,

STRONTIAN COMBINED WITH SULPHUR.

Strontian is an Earth newly discovered; and resembles Barytes in some particulars, but it is not so heavy, and is generally of a sparry texture; often of a very light blue colour, and is then called *Celestine;* it occurs granular, fibrous, and earthy.

CARBONATE OF STRONTIAN,

COMBINED WITH CARBONIC ACID.

Another variety, called *Carbonate of Strontian*, is green and brown, striated; it is generally accompanied with Earthy Barytes, and is very rare.

Strontian may be known by mixing a little of it, in the state of powder, with Spirit of Wine, which, on being set on fire, produces a beautiful purple flame.

The *Sulphate of Barytes* is most abundant in Derbyshire, and Limestone countries of that formation (it occurs also in Sandstone and Shale); where it is found earthy and crystallized in great quantities, considering it to be a veinous production.

The *Carbonate* is much more scarce, and although it is produced in small proportions in three or four mines, it is most plentiful near Chorley, in Lancashire.

Sulphate of Strontian, in small quantities, is not uncommon; but the great repository for it is near and about Bristol.

The *Carbonate of Strontian* is extremely scarce, and exists only at Strontian, in Argyleshire; although small portions are *said* to have been discovered at Lead Hills, in Dumfriesshire.

DESCRIPTION OF ROCKS,

WHICH COMPOSE WHAT IS TERMED THE

*PRIMITIVE FORMATION**.

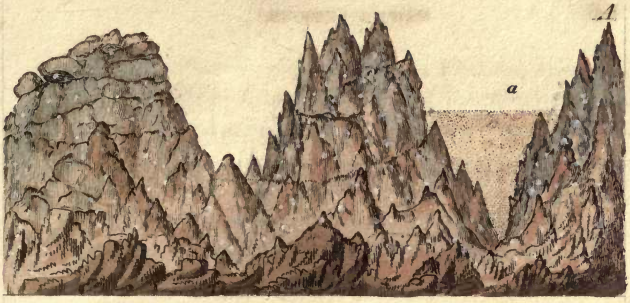
LESSON V.

After having described the Earths as they commonly occur, it will be proper to explain what is meant by the word formation, when applied to Earthy substances.

Geologists agree that there are certain Rocks more ancient than others, and have denominated those which are considered the oldest, *Primitive Rocks.* Thus, those

* The word Formation is meant to convey to the mind of the learner that the crust of the earth has been formed at different and distant periods; hence each period is called a Formation, as the Primitive, Secondary or Transition, Floetz or Flat, and Alluvial.

Geological Collections may be obtained at a cheap rate, with the name and description of each specimen, explaining to what Formation it belongs, by which the learner will be enabled to determine the substances he may generally meet with. These collections, on a small scale, will be interesting to those who read books upon Geological subjects, and may be purchased at from Two to Ten Guineas. The time necessary for selecting, arranging, and describing, forms a considerable part of their cost.



Primitive Rocks.

Primitive Rocks & Secondary.

Stratified Rocks Stratz Formations and alluvial deposit.

J. Cross sculpt. 10 Cavendish Street.

of Granite, &c. are said to be of the Primitive Formation, whilst others are considered of the Secondary or Transition, and a third class are styled the Floetz or Flat Formation, being formed upon the Primitive or Secondary, and bounded by rocks of that description.

It is not my intention to point out where these Rocks are to be found, except in particular cases, nor do I think it necessary to enumerate *all* their varieties, but to explain to the beginner the characters by which they may be known, after having examined a few specimens, without entering into the particular form of the substances which compose them; therefore, as Granite is considered of the first or oldest formation, I shall commence a general and brief description of some of its varieties.

Although the Crystals of *Quartz*, *Felspar*, and *Mica*, are commonly so confusedly aggregated, and intermixed with each other, yet they often occur distinct, particularly on the surface of pieces wrenched from hollows or cavities; therefore, in order that the learner may have a correct idea of these substances, I will place them separately.

Quartz. Crystallized, or in fragments.

Felspar. Crystallized; shewing its foliated, also its uneven fracture.

Mica. Foliated and crystallized; soft, and easily scratched.

Granite, composed of large crystals of Quartz, Felspar, and Mica, distinctly or confusedly aggregated, as the Grey Granite, on Dartmoor.

Granite, common variety, neither large nor small grained, being composed of Quartz, Felspar, and Mica, in regular proportions.

Granite, small grained, colour generally grey; often occurs with Garnets imbedded in it.

Granite, composed of bronze coloured or dark smoky Mica, sometimes almost black; the Mica predominating.

Granite, Graphic, is composed of long crystals of Quartz, imbedded in Felspar, and when broken across, exhibits Hebrew-like characters, hence called *Literatus*. In this variety the Felspar and Quartz shew their characters very distinctly, and the Mica occurs in thick patches.

Red Granite, so called when the Felspar predominates and is of a red colour, is common in Scotland; the Cathedral, on the Isle of Icolmkil, is built of it.

Granite, the Felspar of which is disseminated and decomposing, or quite soft, forming Clay; the Mica and Quartz appearing unaltered *.

Granite, composed of Felspar and Quartz, approaching granular, with Schorl distributed, and a small portion of Mica, also contains large and perfectly defined

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* Felspar contains more or less Alkaline matter, which subjects it to decomposition, as has been before stated.

Crystals of Felspar imbedded. This variety is called Moor-stone in Cornwall, and some have named it Porphyritic Granite; it may be seen in the pavement of London, particularly after rain, the Crystals of Felspar protruding above the surface. This variety differs much in the proportions of its constituents; it frequently contains Hornblende, and the finer part of this Granite resembles SIENITE. Garnets, Tourmaline, and Schorl, are often imbedded in it.

White Stone, is fine-grained, consisting chiefly of granular Felspar, with particles of Schorl, and sometimes Garnets, it often appears as if in decomposition; it is associated with Quartz and Mica, and is probably a variety attendant on Granite.

Gneiss, is Quartz, Felspar, and Mica, the latter lying parallel, forming thin beds, and has been called slaty or stratified Granite, which it really is.

Another variety is, by some Geologists, called Gneiss, when Hornblende forms a constituent, without its being in stratification.

Sienite is composed of crystals of Felspar and Hornblende, confusedly aggregated; it is commonly very hard and of a dull red colour, as that at Mount Sorrel, in Leicestershire; it occurs also grey and dark green. Sienite is not very abundant, and is often taken for Granite. The grand head of Memnon, in the British Museum, and the colossal figures in Egypt, are called *Sienite*.

Sienite, when composed of more Hornblende than

Felspar, is often called Green Stone, of which there are many varieties, indeed the term Green Stone depends much on the colour.

Topaz Rock, in appearance, resembles Gneiss, but consists of granular Quartz, Schorl in spiculæ, Topaz, and Lithomarge (Clay) in layers. Topaz and Quartz are commonly crystallized on some part or other; it is generally of a grey colour.

Mica Slate, is Mica and Quartz laminated, or Mica disseminated in small crystallized particles, having a slaty texture; it is abundant, and has frequently Garnets, Schorl, and Precious Stones, imbedded in it. Mica Slate has often an undulating and curved structure; in some cases it appears almost wholly composed of Mica. This variety consists of very fine particles, which pass into Clay Slate. The Topaz mines in Brazil are situated in this substance.

Quartz Rock is both massive and granular; it frequently contains Mica, and sometimes Talc, a substance resembling Mica; also often large portions of Tourmaline and Schorl; it is then called Schorl Rock. Topaz, Garnets, Fluor, and Pyrites, are sometimes imbedded in it.

The following (called) Primitive Rocks probably were not formed at the precise epoch of the preceding.

Clay Slate is next in abundance to Granite, and often

alternates with rocks of that order, forming mountains, filling hollows, &c. It is called Killas in Cornwall, and in it many metallic veins occur, particularly those of Tin and Copper, also Lead; the latter is commonly rich in Silver. Clay Slate is generally of a dark colour and earthy; it is also slaty and shining, sometimes appearing as if composed in great part of fine particles of Mica; these varieties soon decompose. Slate used for roofing and paving, belongs to this order; in it crystallized Pyrites and Rock Crystal, finely defined, are frequently imbedded.

Flinty Slate, is of a black colour, hard and compact, texture very fine; appears an intimate combination of Hornblende and Silex; it contains numerous capillary Quartz veins. Lydian Stone is a fine-grained variety; it occurs in beds, with Porphyry and Grau-wacce, and in rounded masses in the alluvium.

Porphyry. What is commonly understood to be Porphyry is a hard red-brown substance, enveloping, or containing crystals imbedded in it, which are generally Felspar of a light colour; this variety is called Red Egyptian Porphyry. Green Porphyry is of a dull dark green, with crystals of Felspar of a light green; the ancients called it Oophites, but the modern Italians, *Serpentino.* Brown Porphyry, as that from Sweden, resembles the Egyptian, but is not so hard.

Jaspers of various colours and descriptions are sometimes in fissures in this formation, and constitute veins.

Jaspers are commonly very hard, fine texture; generally of a red or dull green colour, often striped, and contain a large portion of Iron.

Serpentine * is not very abundant in this country, and when associated with Primitive Rocks, it is considered of that formation. Serpentine is composed of a large portion of Hornblende, and commonly dark coloured, as brown red, with reddish marks, or dull green, variegated; it occurs also lighter or darker, often spotted, sometimes with splendent shining Hornblende. Some varieties appear more compact than others: and after examining a few specimens, it may generally be known by its different colours, and being rather greasy to the touch; when breathed upon, it gives an earthy odour; it is soft, easily scraped; in it Native Copper has been found in delicate ramifications and leaf-like. This stratum contains veins of Talc and Steatite, both compact and earthy; also, Asbestos and Magnetic Iron Ore in small particles.

Primitive Trap. This substance is of a dark colour, approaching black, and composed almost wholly of minute crystals of Hornblende. It is hard and difficult to break, and has sometimes an homogeneous appearance; in some cases probably it migrates into Chlorite slate. There are other varieties that are granular, compact, and slaty, which have been confounded with Basalt. In decomposition they appear highly ferruginous, and with numerous vesicles.

Green Stones, composed of Felspar and Hornblende, belong to this formation when associated with Primitive Rocks, and may be distinguished from those of the Se-

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* *Serpentine.* This class is of various colours, sometimes resembling the skin of serpents; hence its name.

condary Formation, by their constituents, being always crystallized and harder; they differ from Sienite principally in colour, and are considered to contain a greater proportion of Hornblende.

Primitive Limestone is crystallized; it appears coarse and granular, as Dolomite and Statuary Marble, or compact, as the Limestone from Tiree, where it occurs of a beautiful flesh-red colour, enveloping Sahlite and Titanium; it effervesces with acid, and easily yields to the knife. Another variety, from Scotland, is clouded pale green; it is of close texture and granular, and receives a high polish. The learner will know, before he has read thus far, how to discriminate Limestone from any other substance.

Primitive Gypsum, is so named, from associating with Primitive Rocks; it is soft, yields to the nail, and is both granular and compact; often contains Talc or Mica. The Italian Alabaster is said to be Primitive. As a formation it is of little importance; it occurs filling cavities of small extent.

Many new substances have lately been discovered in this formation, but their application at present is confined—probably future experiments may develop their use; the learner will feel great interest in discriminating a substance hereto unnoticed. We are indebted to the Swedish chemists, whose recent researches have discovered Lithon, Thorina, and Cerium.

OBSERVATIONS.

THE surface of Primitive Rocks may be supposed to have been much altered since they were formed; split, separated, and scattered in all directions; whether this has taken place from desiccation or other causes, we know not, but they appear without any regular order, presenting rude, barren, perpendicular, and overhanging appearances, with pointed elevations, supposed to have been formed before the creation of vegetable or organized matter. Such mountains may be supposed to be represented in plate A, which is intended merely to give the learner an idea of rugged Alpine scenery. Thus a valley may be filled by a deposit of Blue Clay, Sand, &c. as *a*. The greater part of the Globe being still covered by Sea, great alterations and changes must be constantly taking place, from the inhabitants of the deep forming their coral abodes, and the effects of currents sweeping oceans of deterus amongst them, producing reefs of coral rocks of great magnitude and vast extent.

This short account of what are termed Primitive Rocks, when understood, will enable the learner to determine and distinguish them from those of the other formations; but it is necessary to observe, that hollows, rents, or fissures, may be filled, not only with metallic ores, but with varieties of their own rock species, as

Granite, Sienite, Porphyry, Jaspers, Hornstones, Green Stones, Calcareous Spar, &c. &c.

Clay belongs to every formation, being the natural result of the Argillaceous substances when decomposed.

Granite and Clay Slate are the predominant rocks in Cornwall and Devonshire. The Malvern Hills are a Granitic formation; also those in Charnwood Forest; it then makes its appearance again in Westmorland and Cumberland, and is predominant in Scotland.

The high mountains in Scotland—the *Alps*—the ridge in *Brazil*—the *Cordilleras*—and the *Himalayan* chain in Asia, are of Granitic formation.

Observations

ON

THE SECONDARY FORMATION.

See B. Plate A.

LESSON VI.

THE Globe being formed, Land and Water separated, the natural result of Time, would evidently produce great changes; thus the disintegration and decomposition of the Primitive Rocks, both above and below the sea, the action of the atmosphere, and various deposits of which we have but little idea, must naturally produce another class of earthy substances, Rocks, that are supposed to have been formed before, and in part after vegetable and animal creation; but it is a received opinion that creation was confined to the marine animals, and those at this epoch were of the testaceous and sluggish class, which were not in abundance; these conjectures are founded on the few petrifactions or remains hereto discovered in this class.

The rock that forms the principal feature in this formation is called Grau-wacce, a mechanical deposit; the

others are Transition Trap, which may be both chemical and mechanical, Transition Limestone, and Flinty Slate; these are the limits of the Transition formation, following the present system, although, no doubt, there are many other rocks accidentally dispersed amongst them, and generally composed of particles, precipitated both mechanically and chemically. The most important of this series is considered a mechanical mixture or deposit, and may be compared to a mud bank in a river; but when it appears more or less crystallized, it is supposed that those crystals are formed by a chemical combination of their component parts, influenced by attraction and affinity, which is necessary to constitute a chemical deposit.

Grau-wacce is considered the first mechanical deposit *; that is, an aggregate cemented by Ferruginous Clay, and composed of the debris of the Primitive Rocks, whether coarse or fine, compact or slaty, granular, rounded, &c.

Grau-wacce must, therefore, be considered extremely different in its appearance and texture, often resembling coarse Sand-stone; from its nature, its constituent parts are very various. Its colour is generally dark, dull, often greyish, and its base is argillaceous, cementing together fragments of the older rocks, grains of sand differing in size, angular and rounded Pebbles, also patches of indurated Clay or Flinty Slate, and has sometimes, when composed of fine particles, a slaty texture,

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* A substance entirely formed by the disintegration of others, is called a Mechanical deposit.

and homogeneous appearance; is of considerable extent, and highly metalliferous, *i. e.* contains metallic veins. It is difficult to describe Grau-wacce, so as it may be known. It is necessary to see some well-defined specimens before a correct idea of it can be obtained. Some varieties are much harder than others.

Grau-wacce Slate is in greater abundance and of finer texture; has evident marks of stratification; it has a more homogeneous appearance; in this formation hollows are sometimes filled with Limestone, which contain marks of the remains of marine petrifactions.

Secondary Limestone is generally considered that which is associated with other Rocks of the same formation, connected with those of the Primitive; this Limestone is a deposit more mechanical than chemical, and scarcely can be called granular; its texture is fine, and its colours very variable, and frequently strongly contrasted, as red, black, white, yellow, &c.; it is abundant in Devonshire, both at Torbay and Plymouth, where it exhibits marks of stratification; some varieties, when cut into slabs and polished, are very beautiful; the streets of the town of Dock, at Plymouth, are paved with it. In the north of Devonshire, near Castle Hill, this variety of Limestone occurs, filling large cavities in Grau-wacce Slate. In it are many sparry white veins, and abundance of Pyrites. Fossil petrifactions occur, but not of the same description, nor in any degree so abundant, as in the Limestone of the Flat or more recent formation.

Patches and beds of Green Stone sometimes associate irregularly with this Limestone.

Transition Trap is composed of Hornblende, Ferruginous Clay, Felspar, and granular substances, and is in part both a mechanical and chemical deposit. Varieties appear more or less crystallized; they are hard, contain a large portion of Iron, and alter their appearance in every stage of decomposition, to which they are subject.

Numerous Green Stones belong to this order; they are composed chiefly of Hornblende and Felspar, intimately blended, sometimes partially crystallized. The Green Stones of this class are generally of a dull green colour, and often brown black; they are traversed by small veins of Quartz.

A substance, of an earthy dull appearance, vesicular, and partly decomposed, is called

Wacce. Being cellular and like burnt Clay, it has often been supposed to be of volcanic origin, without considering that such vesicles may have been formed by air or water, or by the decomposition of some alkaline substance.

Amygdaloid is another variety, containing almond-shaped nodules of Chalcedony, Zeolite, Green Earth, Agate, Jasper, and is often vesicular. It occurs hard, soft, and earthy, according to its state of decomposition; further description will avail the learner but little; specimens must be examined to be known.

Trap is the Swedish term for ladder; some Green Stone Rocks, Basaltic Rocks, and Hornblende Rocks, commonly appear as forming steps, hence Trap, ladder. It is particularly visible at Staffa, and in various parts of

Scotland, and other places. Rocks of this class decompose into Clay, the exterior of which is frequently soft and ferruginous, and the interior unaltered.

Transition Flinty Slate, is a siliceous substance; which occurs in thin strata, with Grau-wacce and Secondary Limestone; it is compact, and marked by alternate lines stratified, of a dark or lighter colour.

Of this, the Secondary Formation, Grau-wacce is said to be the only one that is metalliferous; in it are situated many strong and large veins of Lead Ore, both in Scotland and the north of England. The Grau-wacce formation is no doubt more extensive than has hitherto been suspected, and substances now known by other terms, will probably come under this denomination.

The engraving B, plate A, is intended to shew Primitive Rocks, blunted by decomposition, and the Transition Rocks, forming from their disintegration upon their bases, skirting them.

It is highly probable that more varieties will be ranked in this class; when our ideas become unfettered, our reason will have larger scope for fair play, and no doubt discoveries will be made, and arrangements formed, in opposition to the present system, which appears to be unfolded with great obscurity; nor is the following free from objection.

FLOETZ OR FLAT FORMATION *.

C, Plate A.

This formation is supposed to be more recent than either of the preceding, and stated to be formed by deposit *(chiefly mechanical)* from the debris of the others, and the result of organic remains; resting upon the Primitive or Secondary, having been formed at various epochs, and by various operations, filling or rendering more flat extensive valleys between elevated Rocks of the Primitive class. This order is very general throughout a great part of the globe, and shews evident signs that it has been chiefly deposited and formed under water, after which alterations have taken place, from the visible confusion and irregularity of the strata.

It is my desire to endeavour to explain the substances which compose this formation, so that they may be known from others, rather than attempt to account for the manner in which it may have pleased the All-wise that they should be produced.

The plate C is intended to exhibit the appearance of stratified Rocks, as Limestone *a*, *b*, *c*, also a section of a perpendicular vein of Lead Ore, *v*, and a flat or pipe vein, shewing its position *p*.

The letters *f*, *f*, shew the separation of the rocks, and irregularities of the surface in this Limestone; patches

* The learner must not expect to find this arrangement or description to correspond perfectly with any peculiar place, as the different rocks which are comprehended in it may be very distant from each other.

of Trap or Toadstone occur imbedded, independent of the regular series of that formation. This stratum is considerably below the Coal.

The beds of Coal are represented by *d, d;* they are independent of each other, having earthy deposits, as indurated Clay and Sandstone; between them, *g* is meant to shew the direction of a Whinstone dyke passing through the Coal beds, which it breaks and throws into great confusion. The surface *e, e, e,* is intended to represent the situation of *Clay basins*, fresh water deposits, gravel, and alluvial deterus.

The Coal formation is attended by compressed stems of plants, reeds, ferns, and numerous other vegetable impressions, frequently carbonized and imbedded in Micatious grit, Shale, and Clay Ironstone, also fresh water shells.

Following the Wernerian arrangement, the first substance belonging to it is of great extent, and called

OLD RED SANDSTONE,

Or, *First Sandstone.* It rests upon some of the preceding, and is chiefly formed from their decomposition, particularly Grau-wacce, with some varieties of which it is closely connected, frequently having more the appearance of decomposed Ferruginous Clay than Sandstone; it is commonly red-coloured, approaching earthy; it is considered of great extent, particularly in Devon-

shire and Wales, and interposes betwixt the Secondary Formation (upon which it rests), and the Floetz Limestone. It is not considered metalliferous, nor does it often contain either minerals or fossils. As the Transition Rocks are, from their nature, more subject to decompose than the Primitive, this Sandstone may be allowed to be generally formed from them.

First Floetz Limestone; Metalliferous and Mountain Limestone. It is supposed to lie immediately above the preceding, and to be chiefly formed of marine exuviæ; it is of great thickness (probably never cut through, although numerous mines are worked in it); it is regularly stratified, and in parts almost entirely composed of fossil shells: it is moderately hard and compact, rarely granular or crystallized, presents lofty mountains and deep ravines, exhibiting evident signs of having been disturbed by some cause that has thrown the surface into great confusion, by which numerous Metallic veins are exposed.

In this stratum marble of great beauty is found; some of the beds are composed of Corals, Astroite, and Madreporite, which, when cut, have a stellated appearance. Others exhibit almost an entire mass of Marine Fossils, chiefly the Entrochite, Belemnite, and Gryphite. These Limestones, when strongly rubbed with a harder substance, have in general an unpleasant smell.

There are doubtless many formations of Limestone partially distributed, to which it is impossible to attach systematic regularity of situation.

First Floetz Gypsum, Werner considers extensively distributed, and places its situation upon the preceding

Limestone: it is soft, granular, and compact; sometimes contains crystals of Quartz, Boracite, and Andalusite. It is met with in various parts of Europe, associated with Rock Salt and Clay.

Second or Variegated Sandstone. Is a deposit of fine granular Sand, often striped red, brown, and yellow; it is of considerable thickness and extent, contains a portion of Clay, with Oxide of Iron and Mica; it consists of beds more or less thick, is widely dispersed, and used for various architectural purposes.

Second Gypsum. This consists of the compact and fibrous varieties, with Selenite; it is of considerable extent, filling cavities and forming hills, accompanied by Red Marl and resting upon Sandstone; it is in abundance in Derbyshire and Nottinghamshire, particularly near the river Trent; no metallic substances nor fossil remains have been hitherto observed in it in this country.

Second or Shell Limestone. As its name imports, is chiefly composed of shells, and is considered of more recent formation than the preceding; it is soft, loosely cohesive, generally of a light brown colour, and has sometimes a shining and foliated fracture. It frequently constitutes and abuts in irregular mountains. In this formation there are many basins of Sand, Gravel, Blue Clay, &c. (probably arising from the desiccation of lakes) filling up ravines and bounded by Limestone hills. Mineral waters, saline, magnesian, and chalybeate, are sometimes discovered in these deposits at various depths from the surface. The Oolites formation is considered

to belong to this class; it is rarely metalliferous; the range of mountains in Dorsetshire, Somersetshire, and Gloucestershire, are varieties. It is much used for building, and so soft as to be cut with the saw.

Rock Salt, is clear and transparent, or coloured red and brown, rarely blue; it is situated in basins of Gritstone, though it is considered to belong to the Gypsum formation; it is surrounded in this country by Sandstone, indurated Clay, and Marl, always attended by Gypsum, and sometimes thin beds of Limestone.

Chalk. This formation (supposed to be one of the latest of the Limestone class) occupies considerable space in this country, and rests upon Sandstone. It is too well known to need any description; in it are regular beds and nodules of Flint. This singular variety of Limestone contains numerous fossil remains, particularly Echinite, Pinite, Dentalite, &c. &c.; it alternates with Sandstone, which often appears both above and below it.

In the valleys of the Chalk formation are large deposits of Sand and Clay, some of which are several miles in extent; London is built on one of these, hence called the London Clay basin. In these Clay deposits are a variety of fossil shells, &c.

LESSON VII.

COAL FORMATION.

Of this substance, and its usual attendants, something has been said before.

Coal. Its high importance to mankind, and peculiar application to our manufactures, as well as our necessities and comforts, render it indispensable in this country, and I may fairly ask, what could we do without it, or substitute for it?

Coal is met with in various parts of the Globe, and though thin veins and patches may have occurred in Granite, Limestone, &c. it is considered to belong to the Floetz Sandstone formation, and lays in strata, alternating with it.

Compact Coal. *Canal Coal,* often exhibits a wood-like structure.

Foliated Coal. Is shining, and often stratified, with fibrous Charcoal.

Slaty Coal. Has a dull and earthy appearance.

Irridescent Coal. A variety of *foliated,* and often exhibits beautiful colours, hence called Peacock Coal. It is also sometimes covered, as if plated, with shining Pyrites.

Bovey Coal, Ligneous Coal, and Peat.

These varieties belong to the Alluvial deposit, and are met with a little below the surface.

Bovey Coal has a very perfect wood-like texture, and is of a brown colour, rarely carbonized.

Peat is sometimes partly carbonized. It is composed of vegetable fibre, and in some situations fills hollows denominated peat bogs, morasses, &c. It appears to be passing into Coal, and probably only wants a covering of the Sandstone deposit, sufficiently thick to exclude it from the air, to complete the process.

Query. Suppose fermentation to take place, and heat produced under pressure, would it not become carbonized, and form coal?

Another class of rocks is styled, by Werner,

NEWEST FLOETZ TRAP FORMATION.

It consists of Basalt and its varieties, Wacce, Amygdaloid, Trapp Tuff, &c.

Basalt is considered either homogeneous, or composed chiefly of black coloured Ferruginous Clay; it is of close texture and heavy.

Basalt also contains Iron Sand, and has frequently a Porphyritic structure, enveloping small dark green patches of Olivine, which have a glass-like fracture; also a black substance, called Augit, granular and crystallized, together with Hornblende, and sometimes Quartz, Chalcedony, and Calcareous Earth. It is rather difficult for the learner to discriminate the Crystals of Augit from those of Hornblende, until they have been properly explained.

Basalt has frequently a columnar structure, and its exterior is commonly porous (arising from the decompo-

sition of some of the substances), which, in various cases, gives it a cellular appearance, not unlike lava.

Basalt is frequently Amygdaloidal, and contains Calcareous Spar, Green Earth, Clay, Zeolite, and Chalcedony; is often vesicular, and may, in many cases, be considered to decompose into the following.

Wacce. Has the appearance of a cellular indurated Clay. The Augite, Olivine, &c. which were imbedded in Basalt, probably becomes decomposed in Amygdaloid, hence forming vesicles, and finally passes into Wacce and Clay.

Grey Stone. Apparently a variety of Basalt, containing a mixture of Felspar; it is hard, of a dark colour, and has a coarse fracture.

Porphyry Slate, Clink Stone. A substance nearly allied to Basalt, and generally associates with it. It is of a fine texture, dull green colour, often clouded darker or lighter, has a conchoidal fracture, and is translucent at the edges. When struck with a hammer, it gives a metallic sound, hence its name.

Trap Tuff, consists of fragments of the preceding rocks, cemented together by an earthy base, forming a coarse *breccia.*

Green Stone occurs in this as well as the preceding formations, but it is considered less crystalline, and to be composed of finer particles, so as often to resemble a simple substance. Its colour is usually dull green of various shades, sometimes reddish, and then called Sienitic Green Stone.

Amygdaloid. This rock appears to have a Clay base, and is probably a variety of Grey Stone or Green Stone, in different stages of decomposition. It associates with Basalt, and perhaps passes from it into Amygdaloid: it contains vesicles filled with Calc Spar, Green Earth, Lithomarge, Zeolite, Chalcedony, black spots of Hornblende, also Quartz and Agate; it has often a vesicular structure, and has frequently been taken for a Volcanic substance.

VOLCANIC.

Rocks of Volcanic origin are supposed to be of modern formation, at least we know of many that are so. Volcanos are not confined to land only, for we have instances of islands rising out of the sea and sinking again! It is stated that there are upwards of two hundred active volcanos, many of which, at intervals, discharge lava and ashes in immense quantities; the heat is frequently so great (more especially during an eruption) that it acts upon the neighbouring rocks, giving them the appearance of volcanic origin. From Etna alone have been issued mountains, and territories formed of great extent, and the matter ejected has covered towns, filled valleys, and totally changed the face of the country.

Sulphur, so generally combined with Minerals, occurs in immense quantities in and about Volcanos; it is too well known to need any description. Numerous Salts, of various combinations, are also found sublimed in the craters of Volcanos.

Volcanos in South America and Kamschatka do not appear of less importance.

There have been also many volcanos which are now extinct, but have left sufficient marks of their existence. These have no doubt altered the face of nature in their vicinity; therefore it may be supposed that this formation is of much greater extent than has been imagined, and may be said to consist of numerous varieties, viz.:

Rocky substances, altered by subterraneous heat, or ejected from volcanos.

Lava. Compact or cellular; numerous varieties.

Obsidian, and Porphyritic Obsidian.

Vesicular Lava; Porous Lava, Pumice.

Volcanic Tuff. The debris of volcanic productions cemented together.

Volcanic Ashes.

Volcanic Sulphur.

Earthquakes that have shaken the globe, ingulfed whole districts, and raised mountains where plains once existed, separated rocks, and thrown them in the greatest disorder, forming ravines and abrupt precipices, may be supposed to result from the effects of volcanos.

There are immense siliceous deposits from the hot waters of Iceland, resembling the calcareous Tuff, in some of which are patches which common observers

would take for flint, if the surrounding spongeous substance was detached. It may also be added, that the solvent power of hot water, when containing Alkaline substances, is in a great degree unknown. Those who have examined the waters of Iceland are well aware of the siliceous precipitates, some parts of which much resemble Chalcedony, also Hornstone, and Flint.

ALLUVIUM,

Containing Diamonds, Gold, Precious Stones, Mica, Sandy Iron Ore, &c.

This deposit has given great riches to the world, and is generally understood to consist of the loose earthy soil which covers the solid rock in every part of the globe, but more particularly the beds of rivers and water courses, whether left by floods or formed from the decomposition of the adjacent mountains; it has in general a gravel-like appearance, intermixed with pieces of rock of a larger size. These deposits are called Gold Mines in Brazil and Africa; they are often of great extent, forming the low-land bordering on a rivulet. The precious Metal is found by washing the soil by hand in wooden bowls of a conical form, and about fifteen inches across; by keeping up a continued agitation, the Gold, from its weight, sinks to the bottom.

The Alluvial Soil (as has been before stated) is washed for the Ores of Tin in Cornwall, also in the Island of Banca, where it is in great abundance, and sometimes accompanied with Gold, &c.

Calcareous Tuffa is in great abundance in Limestone countries, particularly Derbyshire, at Matlock, where it forms hills on the banks of the Derwent; in it are found Land Shells, Deer-horns, Wood, &c. The spring waters in their course lose a part of the carbonic gas, and precipitate the earth held in solution, on moss and vegetable fibres, until their source is frequently choaked. Those springs are called petrifying wells, because straw or sticks that are placed in them become incrusted.

Alluvial Soil is moved by high tides, currents, and inundations, often forming shoals at the entrance of rivers, and on various parts of the coast. Nay, heavy gusts of wind carry quantities away, appearing like a moving cloud, and changing the face of the country wherever it is deposited; nor is it uncommon for trees and herds of cattle to be covered by it.

Alluvial Soil—containing Diamonds, &c.—Brazil.

Alluvial Soil—containing Gold, Iron Sand, &c.—Africa.

Alluvial Soil—containing Rubies, Chrysoberyl, Hyacinth, Jargoon, &c.—Ceylon.

Alluvial Soil—containing Tin Ore, &c.—Cornwall.

This formation demands more notice; it is easily investigated, and is composed of the debris of the solid and moveable earthy contents of the Globe. Substances found in it have led to important discoveries.

After having concluded the foregoing pages on Geology, the student will be led to reflect on the division of the various and extensive order called rocks, whose characters are so obviously different from each other. Although, however difficult to fix their formation to any limited period, yet the structure of many of them conveys distinct symptoms of their relative age, as may be clearly seen in a small collection of select specimens;—for instance,

Imagine the sea to leave a certain part, and rocks appearing, formed by the zoophytes which construct huge reefs of coral rock, resting upon and covering those of a different quality, and of a prior existence.

Submarine volcanos also may have been very active, and poured forth immense tracts.

The accumulations on the coasts—the filling of harbours and arms of the ocean—the retiring of waters—are evident to our senses; but the operations that are going on in the deep recesses of the earth, or below the unfathomable waters, are infinitely beyond our comprehension.

"Works of the power supreme, who pour'd the flood
"Round the whole earth, and call'd it good."

Then may we exclaim, can any mind be so vacant or insensible as not to notice the exact forms which minerals present? They are the geometry of nature, formed with mathematical exactness. Examine a piece of Calcareous Spar, break it, and every fragment is a rhomb—see a cube of fluor—a perfect hexagonal of Quartz—an octahedron of Diamond—of Iron—or of Lead Ore; or a dodecahedron of Garnet! then contemplate the laws by which these forms are produced in the mysterious laboratory of nature, directed by the infinite power of the Creator.

Werner has classed the Metals and Earths in the following Order. The varieties belonging to each may be seen in any Elementary Work, or in the New Descriptive Catalogue.

CLASSIFICATION OF METALS.

Platina.	Tin.
Palladium.	Bismuth.
Irridium.	Tellurium.
Gold.	Antimony.
Mercury.	Molybdena.
Silver.	Nickel.
Copper.	Arsenic.
Iron.	Tungstein.
Manganese.	Tantalum.
Titanium.	Cerium.
Lead.	Cadmium.
Chrome.	Selenum.
Zinc.	Wodanum.

CLASSIFICATION OF EARTHY MINERALS.

These are arranged in what are called Families, and each is divided into Species and Sub-Species, comprising great Variety.

Diamond.	Azurestone.
Zircon.	Felspar.
Ruby.	Clay Slate.
Schorl.	Mica.
Garnet.	Lithomarge.
Quartz.	Soapstone.
Pitchstone.	Talc.
Zeolite.	Hornblende.

Crysolite.	Gypsum.
Basalt.	Boracite.
Dolomite.	Baryte.
Limestone.	Strontian.
Apatite.	Hallite.
Fluor.	

SALINE MINERALS—Earthy Salts.

Alum.	Epsom Salts.

ALKALINE SALTS—Salts of Soda.

Natron.	Rock Salt.
Sulphate of Soda.	Borax.
Reussite.	Native Boracic Acid.

SALTS OF AMMONIA.

Muriate of Ammonia.	Sulphate of Ammonia.

METALLIC SALTS.

Sulphate of Iron.	Sulphate of Copper.
Sulphate of Zinc.	Sulphate of Cobalt.

INFLAMMABLES.

Sulphur.	Graphite.
Bitumen.	Resin.
Coal.	Retin-Asphalt.

Description

OF

COLOURED PLATE.

SEE FRONTISPIECE.

A BRAZILIAN MINER WASHING THE ALLUVIAL SOIL FOR GOLD AND DIAMONDS.

This plate is taken from a view in Cerro de Frio, in Brazil. The situation is a ravine through which a stream of water runs, called Mielho Verde; it is bounded by mountains of Granite, large blocks of which lie in all directions.

In the summer season a part of the bed of the rivulet becomes dry, and the course of the stream is often changed by placing planks in such a manner, as to lay bare the other part, in order to remove the gravel or soil which has been deposited after heavy rains; for this purpose people are employed in digging, raking, and carrying it away to the nearest plain, where they throw it into a heap. It is generally observed that the soil nearest the solid rock is most abundant in grains of Gold and in Diamonds, consequently the surface of the rock is scraped, and not an atom of the Alluvial Deposit suffered to remain. When the rains commence, and

the water is in sufficient abundance, the most skilful miners are employed in carefully washing this soil in small conical bowls. The operation is performed as follows: the bowl being in part filled with water, about ten or twelve pounds of the Gravel is put into it, which is continually stirred about until the rounded stones become clean; as the water becomes muddy from the earthy matter being held in solution, it is poured off, and fresh is continually added, until the whole is washed, so as no longer to render the water turbid; then the larger stones are thrown away, and the smaller ones picked out with great care, below which the Diamonds will be found, and at the bottom the grains of Gold will appear, generally accompanied with Iron Sand. The Diamonds are more easily distinguished when wet, having a peculiar semi-metallic lustre.

Gold and Platina, whether in larger or smaller grains, being so much heavier than Pebbles, or the earthy substances in which they have been imbedded, fall to the bottom of the bowl as soon as the earth is washed from it.

The plate represents a heap of Gravel raked from the river, and a smuggler washing it by stealth, as, wherever Diamonds are found, the crown claims the property. In the distance are two negros carrying away the soil—Men frequently go ten or twelve miles in the night, and take a sack of this Gravel, which they wash at home secretly. This is what is called hand-washing. There are other modes practised on a larger scale, which are more expeditious, but not so economical. I have seen eight men procure upwards of twenty ounces of Gold in four hours, from a portion of soil, not above two tons in weight, taken from a deep hole which occasioned an eddy in the river.

COLOURED PLATE.

DERBYSHIRE ORDER OF STRATA.

SEE FRONTISPIECE.

SECTION OF THE STRATA AT MATLOCK HIGH TOR.

THE Section of the Strata at Matlock High Tor, represents the general Strata of Derbyshire, from the coarse Grit down to the lowest Limestone. The reader may suppose himself on the road, and looking down the river; then the broken mountain of Masson and the Cumberland mine will be on his right hand, and the perpendicular face of the High Tor will be on his left; above which, further back, on an eminence called Riber (out of sight), is the stratum of coarse Gritstone (*a*), which is below the coal measures. This Grit is generally of a light grey colour; it is composed of Crystals and rounded fragments of Quartz with Felspar disseminated, and crystallized, having the decided characters of a mechanical aggregate; in it are a few traces of Schorl and Mica; but the Felspar being crystallized, allows us reasonably to suppose it is in part a chemical deposit, which is often the case in compound rocks of this description; it is of considerable thickness—in some places upwards of fifty fathoms; valleys are bounded by it on one side, whilst Limestone forms the other, which indi-

cates that the strata have undergone great changes. This stratum rests upon Shale, and where they approach each other, the Grit becomes lamellar, soft, and often contains thin beds of Schistos.

Bituminous Schistos. *Shale (b)* forms a stratum equal in depth to the preceding; its colour is dark, almost black; it is earthy, and though tolerably hard, yet when exposed on the surface, divides in laminæ, and decomposes into Clay; it has the appearance of being entirely a mechanical deposit, containing some fossil shells and vegetable remains, as stems of trees, impressions of plants, and Clay Iron Stone. Some varieties are so bituminous as to burn, and have been used in limekilns. It appears a compound of fine sandy particles, ferruginous Clay, and Marl, with a great proportion of decomposed vegetable matter. In it are many sparry veins, and frequently fissures of considerable magnitude, filled with Lead Ore and Calcareous Spar, which have been worked in this stratum. This Schistos or Shale rests upon Limestone, and where they are in contact, they partake of the qualities peculiar to both.

The First Limestone (c), which forms the summit of Matlock High Tor, exhibits marks of regular stratification, and is of a grey colour, appearing almost composed of marine remains; in it are numerous veins, filled with Lead Ore and beautiful crystallizations, which commonly divide the stratum in an east and west line; but there are others that cross them, and of course have a more northerly and southerly direction. The veins are often obstructed, and cut off by the abrupt intervention of

a substance provincially called Toadstone, (*v*) is a mine or vein of Lead Ore now worked.

Amygdaloid, first *Toadstone (d)*. A stratum, so called, may be seen about the middle of the High Tor, separating the Limestone and veins of Lead Ore *; it is of a dull grey colour, earthy texture, spotted green, and contains a large portion of Pyrites. Although Lead Ore is occasionally (probably adventitiously) met with in this stratum, yet there is not any appearance of a regular vein (as in the Limestone). On the contra side of the valley, and above the Rutland Cavern, this stratum appears again.

Another description (of what is called *Toadstone*, probably *Basalt*,) is more generally met with in this neighbourhood, which is hard and compact; it appears to be composed of indurated ferruginous Clay, Hornblende, &c. Jasper and Chalcedony also occur in patches; but there is not any trace of petrifactions or organic remains in it.

This substance does not admit water to pass through it, but when in contact with Limestone, the appearance of both are greatly altered; above and below their junction several feet of each exhibit very different characters from those of their usual appearance; it is difficult to determine if the miners have not mistaken the change of the character of Limestone, more particularly when

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* Is it possible that a thin bed of Toadstone, situated betwixt Limestone, may have become so altered, as to lose its general characters? or that Limestone, containing a portion of Pyrites, Magnesia, &c. be so much altered, as to lose its general appearance?

in contact with Toadstone, or if the continued action of water may not have caused Lead Ore to have passed from the vein and penetrated into the latter, mechanically, or from being held in solution.

Underneath the first Toadstone is what is termed the

Second Limestone (e). In its general appearance not unlike the first: it is composed of marine remains, and in it are beds of Magnesian Limestone; the veins of Lead Ore that were intersected by the Amygdaloid, appear again, with all their former richness and characters; *(l)* is a level driven from the edge of the river to carry off the water from the mine: this Limestone varies in thickness, and is divided by a second stratum of Basalt Toadstone, which forms the bed of the river *(r)*, rising to the west, and appears beyond the celebrated RUTLAND CAVERN, formerly called Old Nestor Pipe *(f)*, situated in the Second Limestone; (G), is the entrance into the Cavern. Scarcely a vestige of the First Limestone, or Toadstone, nor any of the great Stratum of Shale, nor that of Grit, appear on the west side of this ravine.

The Second Basalt or *Toadstone (g)*, does not in some cases differ from the first, so that one can be distinguished from the other, except in peculiar stages of decomposition; when forming a part of the surface it appears slaty rather than stratified; it varies in thickness, and, like the first stratum of this substance before described, it cuts off the veins of ore, and separates the Second and Third Limestone.

Third Limestone (h). This stratum is generally

darker coloured than the second, and contains beds of flinty chert; some of which are composed of different marine remains; in it are *patches* of Toadstone, independent of that stratum above or below it. This Limestone is of great thickness; it forms a considerable extent of surface, and contains numerous veins of Lead Ore, which are, as the former, abruptly intersected by

The *Third Basalt* or *Toadstone (i)*, which forms a stratum like the others before named, and with the same characters; its thickness varies, and in some cases, after sinking fifty fathoms, it has not been cut through: it is of considerable extent in the mountainous districts, and rests upon the

Fourth Limestone (k). This stratum is the lowest of the Derbyshire series, and is supposed to rest on old red Sand Stone; it is most abundant in the north of Derbyshire; in it are many veins of Lead Ore, also deep fissures, and grand caverns: its beds or marks of stratification are generally of greater thickness, and less variable than the preceding varieties; it has never been cut through; therefore it may be truly said, that we do not know, or at least are doubtful, upon what substance it rests.

The substance called Toadstone, I find a difficulty in attempting to describe; it is of great extent in the mining district, and in many places has the appearance of Basalt: also Greystone consists of numerous varieties of Amygdaloid. It is not a little singular that this interesting substance should have remained unexplained, probably unexamined in a geological point of view.

Collections, forming a series of Geological Specimens, from the uppermost Coal formation to the lowest Lime-stone, may be had at the *Museum* at Matlock, consisting of Thirty varieties, arranged and described, for One Guinea; or Fifty larger, and containing Specimens from the veins of Lead Ore, at Two Guineas.

Also the finest Specimens of Calcareous Spar, Fluors, &c. at various prices.

The Geologist is particularly recommended to make Matlock his rendezvous for some days, as in its vicinity he will find such variety of strata, so many various productions, caverns easy of access, particularly the Rutland, in which the Toadstone appears: the mountain in which it is situated is called the Heights of Abraham; it is traversed in all directions by numerous veins of Lead Ore, one of which now appears as an open fissure on the left hand, on the side of the road going to and near the High Tor, respecting which, and particulars relative to the Mineralogy of the neighbourhood, every information may be obtained at the Museum.

The beauties of the scenery at Matlock have been described by Moore, an artist of great merit and ingenuity, who has published a small work, entitled, *Picturesque Excursions* in the neighbourhood of Matlock; it contains eight plates, and is expressly calculated to lead the artist to the most interesting situations for the employment of the pencil.

DESCRIPTION

OF THE

Portable Lapidaries' Apparatus,

BY WHICH THE

OPERATION OF CUTTING, POLISHING, AND SLITTING,

MAY BE PERFORMED.

SEE COLOURED PLATE.

THE agreeable amusement of collecting Pebbles, Jaspers, Agates, &c. has of late become so fashionable, that almost every one who visits the coast has been employed in searching for these pretty productions, and forming collections of them; but great disappointment has frequently taken place, owing to the want of a convenient method of cutting and polishing these beautiful substances. To obviate which, a Portable Mill * has been contrived, so as to render the operation easy, and which will afford both instructive and agreeable employment.

This compact Lapidaries' Mill is contained in a small box, and may be placed on any parlour table: the method of using it is explained as follows, viz.

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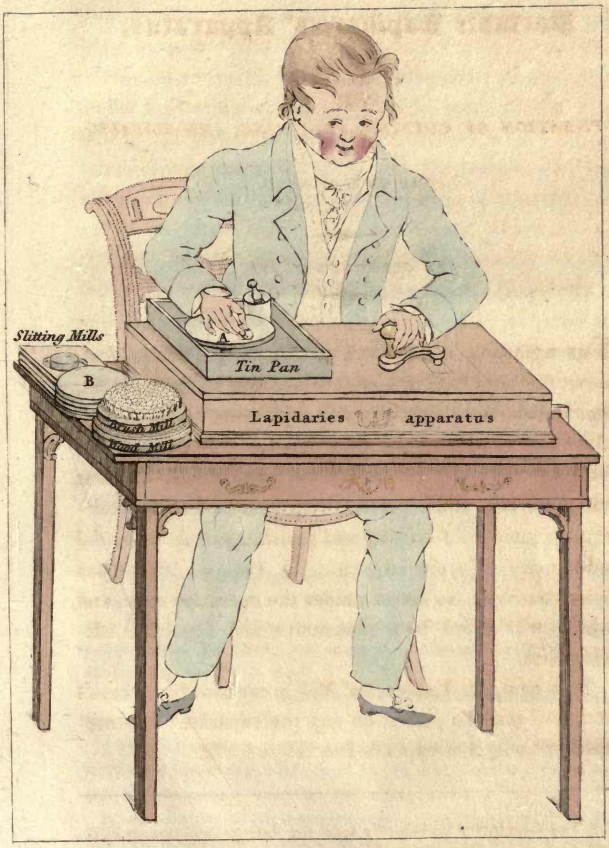
* The Lapidaries technically term the various implements *Mills*, which term in conformity will be used hereafter.


Slitting Mills
B
A
Tin Pan
Lapidaries apparatus
Brush Mill
Wood Mill

First, secure the box to the table (with the cramp) that it may be steady, and then it will be ready for work. A japanned tin pan, with a hole in the centre, accompanies the box, which is to prevent the operator's dress from receiving the water, &c. ejected from the mill when at work *.

Next put the tin pan over the spindle, and screw † on the lead-mill marked A; place the pot, with fine corn emery and water, in one of the corners, and with the brush charge the mill; then turn the handle with the left hand, resting the right on the edge of the pan, and apply the stone, taking care not to lay on too heavy; the mill works best when turned with considerable velocity, in which case it will be necessary frequently to dab the mill with the brush from the emery pot, and almost instantly a plane will be produced: [in this manner facets are cut upon Amethysts, &c.;] when the stone is sufficiently worn down the cutting mill is unscrewed, and the polishing mill, marked B, is screwed in its place, which is used with rotten-stone a little wet; the substance to be polished is applied the same as in cut-

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* There are from three to eight mills, namely, one of lead, one of pewter, and two of soft iron for slitting—a wood mill, one covered with cloth, a brush mill, and one covered with list (soft), to polish shells, &c.; they are marked underneath with what substance they are to be used.

The spindle is spiral, that when the string becomes slack, it may be moved a pulley higher.

† The mills are screwed on and off by firmly holding the pulley within the box with the left hand, to prevent it turning, whilst the right hand screws or unscrews the mill required.

It is advisable for the learner to see a practitioner perform the different operations; a practical lesson would be worth a volume of description!

ting; if it be hard, it will soon receive a fine lustre; but if it be soft and porous, it will take more time; it is necessary to look frequently at it, in order to know how the polish proceeds; a few drops of water must be applied at intervals.

It is necessary to prepare a new polishing mill by scraping it with a knife, or rather hold the edge of the knife lightly upon the face of the mill, and turn it gently round both ways, which gives it a rough surface, and causes it to hold the rotten-stone better.

The Slitting Mill is more delicate than the preceding, and will require to be kept with care, that it may run perfectly horizontal. It is not very generally known how a piece of Agate or Crystal can be cut into slices, being so much harder than steel; for this purpose the Slitting Mill is made of a thin plate of soft iron, the edge of which is armed or charged with Diamond *. The particles of Diamond, on the application of a hard substance, become *set* in the edge, and form teeth; then, with a tolerable quick motion and copious supply of oil, it will cut whatever is applied to it.

After a stone is slit (or rubbed down), and the marks worked out, by the lead mill, it should be washed, and applied to the wood mill with flour emery, or fine sand and water, before it is polished on the pewter mill; after which, and finally, the cloth or list mill may be resorted to, which will heighten the polish, if necessary.

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* *Diamond*, commonly called *Diamond bort*, must be reduced to powder in a steel mortar; then prepare about one-fourth of a grain by rubbing it with a hard muller upon a piece of Steel or Agate, with a drop or two of fine thin oil; then it may be applied by the finger to the edge of the mill, which should be turned gently, that it may receive the diamond dust all round.

There is another mill of copper or iron to be used with coarse emery, which will slit marble and soft substances (milk may be used instead of water); it is advisable the learner should practise and make himself master of slitting stones of this sort, before he begins to use Diamond powder.

These are the mills generally used, but to render this apparatus more complete and amusing, three others are added—one is covered with cloth, and is intended to be used with putty of Tin, and a little water. Marble, Spar, and other stones, that have a plain surface, and do not give fire with Steel, may be polished upon it.

The mill covered with list should be used as the preceding, with putty and water; it is useful in polishing substances with uneven surfaces, as some varieties of shells, &c.

The plain wood-mill may be used with sand or fine emery and water; it is applicable to various purposes, as cleaning rusty Iron, rubbing down Marble, Spars, Gypsum, or Shells. Other mills may be added, with various brushes or leather, for different purposes.

Shells may be uncoated, to shew their pearly appearance, on the lead mill, with coarse emery; then, on the wood mill, with fine sand; and lastly, on the list mill, with putty, which will give them a beautiful polish.

Brush mills may be used to great advantage, either dry or wet.

If a piece of Clay is placed upon the lead, when upon its spindle, it will make an excellent potter's wheel, and cups or saucers may be raised at pleasure. It also forms a good substitute for the grindstone, and may with great ease be applied to many useful purposes.

It is necessary to state that the mills should be kept

in nice order, clean, and separate from each other, as the smallest particle of emery would spoil the polishing mill.

Small stones may be cemented to bits of wood, that they may be held more firmly. A movable lever may be used to apply the stone to the edge of the slitting mill, if necessary.

Cat-gut strings are commonly used, the ends screwed into a steel hook and eye; the inner ends are afterwards burnt with a red-hot wire or knitting needle, to prevent its drawing out; but I have found cotton strings less troublesome, more easily applied, and every way preferable.

The expence of this Apparatus, with Emery, Putty, &c. is from six to eight guineas, according as it is fitted up for various purposes. Some are made as high as ten pounds. It is particularly recommended that those who make use of them, should see a practitioner perform all the operations, by way of instruction.

THE END.

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